



If you have discovered material in AURA which is unlawful e.g. breaches copyright, (either yours or that of a third party) or any other law, including but not limited to those relating to patent, trademark, confidentiality, data protection, obscenity, defamation, libel, then please read our [Takedown Policy](#) and [contact the service](#) immediately

THE EUROPEAN COMMUNITY AND INNOVATION POLICY: REORIENTING TOWARDS DIFFUSION

INNOVATION AND INNOVATION POLICY
TOWARDS DIFFUSION

Bookholt

to the

Patricia Ellen Barbara Boekholt

Doctor of Philosophy

UNIVERSITY OF ASTON IN BIRMINGHAM

September 1994

This copy of the thesis has been supplied on condition that anyone who consults it is understood to recognise that its copyright rests with its author and that no quotation from the thesis and no information derived from it may be published without proper acknowledgement.

THE UNIVERSITY OF ASTON IN BIRMINGHAM

THE EUROPEAN COMMUNITY AND INNOVATION POLICY:
REORIENTING TOWARDS DIFFUSION

Patricia Ellen Barbara Boekholt

Doctor of Philosophy

1994

This study aims to explore the position of diffusion oriented support mechanisms in European Community (EC) innovation policy. With the shift from the traditional linear model towards an integrative approach to innovation, the role of diffusion of technologies and knowledge, achieved greater weight. This shift in both the thinking of academic experts, and of national policy makers, induced EC policy makers to appeal for similar changes in Community innovation policy. From the mid-1980s, the Commission of the European Communities, the key actor in EC policy making, thought to move its innovation policy away from the traditional science push approach. This study shows that in the implementation of programmes for research, technology and innovation, the traditional linear model is still dominant. The core research and technological development programmes still operate from a science push concept of innovation, mainly due to their pre-competitive nature. The case of SPRINT illustrates that policy programmes with an integrated innovation perspective can be successful at Community level. However the programme operates in a relatively isolated position from overall research and technological development policy. The case of BRITE-EURAM illustrates the difficulties of collaborative research programmes, the bulk of EC support mechanisms, to move away from the traditional model. The study shows how conflicting policy objectives arising from the different policy networks that shape EC policy making, in combination with a lack of co-ordination in those policy domains, hinder the emergence of the integrated approach. Consequently EC diffusion policy, implemented from the perspective of the linear model, will have a sub-optimal impact on the competitiveness of European industries.

Key words: research, technology, SPRINT, BRITE-EURAM, industry.

ACKNOWLEDGEMENTS

Writing a thesis is mainly a solitary process, but writing this one could not have been possible without the help of many people. First I would like to thank Fred Steward of Aston Business School, whose efforts made this transnational project get off the ground. His positive comments in our many discussion sessions kept the research process going. Financial support from Aston University was another important factor that made this study possible. The TNO - Centre for Technology and Policy Studies supported me both materially and spiritually. I would like to thank Dany Jacobs and Gustavo Fahrenkrog for providing food for thought on diffusion policy and the European Community. Special thanks to Martina van Amersfoort whose layout skills and efforts made the presentation of this thesis look so much better.

I am grateful to Henry Miller whose hospitality gave me a home base on my many stays in Birmingham.

Last but not least many thanks to Ger Arendsen who formed a one-man multi-support-team during the past years.

CONTENTS

LIST OF ABBREVIATIONS	11
INTRODUCTION	13
1. THE CHANGING ROLE OF DIFFUSION IN MODELS OF INNOVATION AND PUBLIC POLICY	19
1.1 <i>Introduction</i>	19
1.2 <i>A shift in the dominant innovation model in literature</i>	21
1.3 <i>The evolution of the innovation model: consequences for diffusion theory</i>	28
1.3.1 The time paths of diffusion	33
1.3.2 Defining diffusion	41
1.4 <i>Diffusion as a policy concern</i>	43
1.4.1 Diffusion policies in the industrialised countries	54
1.4.2 A taxonomy of diffusion policy	60
1.5 <i>Conclusions</i>	64
2. CONSTRAINING AND FACILITATING FACTORS IN THE EC POLICY CONTEXT	67
2.1 <i>Introduction</i>	67
2.2 <i>RTD policy and EC integration</i>	68
2.3 <i>Member States versus European Communities: the legitimisation of EC responsibility in RTD policy</i>	75
2.4 <i>Competition between Member States over EC RTD policy</i>	82
2.5 <i>Conflicts within the Commission of the European Communities</i>	88
2.6 <i>Conclusions: opposite forces in the policy context</i>	103

3. IMPLEMENTATION OF EC INNOVATION POLICY: THE PRIORITY AREAS	107
3.1 <i>Introduction</i>	107
3.2 <i>Before the Framework Programmes</i>	108
3.3 <i>The first Framework Programme</i>	114
3.4 <i>Towards a European Technological Community</i>	120
3.5 <i>Research after Maastricht</i>	128
3.6 <i>A decade of Framework Programmes: an overview</i>	135
3.7 <i>EC diffusion policy and programmes</i>	139
3.8 <i>Conclusions: a cautious incorporation of diffusion</i>	144
4. DIVERSITY AS A BARRIER TO DIFFUSION POLICY	148
4.1 <i>Introduction</i>	148
4.2 <i>Diversity, cohesion and diffusion: defining the problem</i>	150
4.3 <i>Perspectives of diversity</i>	156
4.3.1 <i>The R&D related perspective</i>	157
4.3.2 <i>The industrial structure perspective</i>	165
4.3.3 <i>The institutional perspective</i>	171
4.4 <i>Conclusions</i>	191
5. SPRINT: THE EUROPEAN COMMUNITY STRATEGIC PROGRAMME FOR INNOVATION AND TECHNOLOGY TRANSFER	196
5.1 <i>Introduction</i>	196
5.2 <i>The historical development of the SPRINT programme</i>	198
5.2.1 <i>The Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer</i>	200
5.2.2 <i>The definition phase 1986 - 1988</i>	206
5.2.3 <i>SPRINT: the main phase (1989-1993)</i>	209

5.3	<i>SPRINT's contribution to the diffusion throughout the EC</i>	214
5.3.1	Transnational technology transfer networks	214
5.3.2	Specific Projects	223
5.4	<i>SPRINT's position within EC policy: constraining and facilitating factors</i>	227
5.5	<i>SPRINT's impact on the approach of policy makers towards diffusion</i>	231
5.6	<i>Conclusions</i>	234
6.	SUPPORT FOR INDUSTRIAL TECHNOLOGIES: THE CASE OF BRITE AND BRITE-EURAM	238
6.1	<i>Introduction</i>	238
6.2	<i>The origin of industrial and materials technologies: basic research in the BRITE programme</i>	240
6.3	<i>BRITE-EURAM: from basic science to applied industrial research</i>	250
6.4	<i>BRITE-EURAM II: stamping out the linear approach</i>	260
6.5	<i>Constraining and facilitating factors in the Community policy context</i>	266
6.5.1	Competence in industrial policy and pre-competitiveness	266
6.5.2	The contribution to social and economic cohesion	268
6.6	<i>Conclusions: BRITE-EURAM's contribution to diffusion</i>	276
7.	CONCLUSIONS	282

REFERENCES	294
------------	-----

APPENDIX I: PERSONS INTERVIEWED	313
---------------------------------	-----

APPENDIX II: SOURCES OF INFORMATION ON EUROPEAN	313
COMMUNITY RESEARCH AND	319
TECHNOLOGICAL DEVELOPMENT POLICY	314

TABLES AND FIGURES

<i>Table 3.1:</i>	<i>Amount of EC financial contribution in MECU and percentage of total funding by field of research in the years 1981 to 1983</i>	113
<i>Table 3.2:</i>	<i>Funding in the first Framework Programme (1984-1987)</i>	119
<i>Table 3.3:</i>	<i>Funding of the Second Framework Programme (1987-1991)</i>	123
<i>Table 3.4:</i>	<i>The third Framework programme (1990-1994) and its funding in MECU, including additional funding in 1992</i>	127
<i>Table 3.5:</i>	<i>Commission proposal, Council position and final decision for breakdown of research funding of the fourth Framework Programme in MECUS</i>	134
<i>Table 4.1:</i>	<i>R&D Financing by chapters of NABS in % of total financing</i>	161
<i>Table 4.2:</i>	<i>Inventions by country/region of origin in all fields of technology</i>	163
<i>Table 4.3:</i>	<i>Accessibility and receptivity to innovative ideas and investments, number of regions per country</i>	189
<i>Table 5.1:</i>	<i>SPRINT main phase 1989-1993</i>	211
<i>Table 5.2:</i>	<i>Type of specific projects</i>	225
<i>Table 5.3:</i>	<i>Increase in budgets for SPRINT</i>	228
<i>Table 6.1:</i>	<i>Research areas in BRITE programme (1985 to 1988) and distribution of budget after project selection in percentages</i>	244
<i>Table 6.2:</i>	<i>Priority areas for BRITE/EURAM: allocation of funds in percentages</i>	255
<i>Table 6.3:</i>	<i>The weight of selection criteria for BRITE-EURAM proposals</i>	263
<i>Table 6.4:</i>	<i>Links established between participants by organisation type in BRITE-EURAM</i>	271
<i>Table 6.5:</i>	<i>Choice of partners in France, UK and Germany as share of all partner links, BRITE-EURAM projects up to 1991</i>	274

Figure 1.1:	<i>Interactive model of the innovation process</i>	24
Figure 1.2:	<i>An interactive model of the innovation process</i>	
	<i>The chain linked model</i>	27
Figure 1.3:	<i>Rate of improvement in terms of key design parameters</i>	34
Figure 1.4:	<i>Dominant diffusion policy support mechanisms in a linear and integrative innovation model</i>	66
Figure 2.1:	<i>European technology policy - levels of analyses</i>	73
Figure 2.2:	<i>Four layers of conflict in EC decision making</i>	76
Figure 2.3:	<i>The decision making process of RTD policies</i>	94
Figure 3.1:	<i>Budgets for the Framework Programmes in billion ECUS</i>	136
Figure 3.2:	<i>The share of funds over six main research areas from 1984 - 1998</i>	137
Figure 4.1:	<i>Gross domestic expenditure on R&D as a percentage of GDP</i>	158
Figure 4.2:	<i>Sources of R&D expenditures</i>	159
Figure 4.3:	<i>Government R&D in the European Community</i>	160
Figure 4.4:	<i>Change in the expenditures between 1985 and 1990</i>	162
Figure 4.5:	<i>Most ingenious firms in Europe by patented innovations</i>	165
Figure 4.6:	<i>Members of TII per country</i>	177
Figure 4.7:	<i>IMD ranking on science and technology</i>	180
Figure 4.8 a:	<i>Ranking on R&D expenditure by country</i>	181
Figure 4.8 b:	<i>Ranking on R&D personnel by country</i>	182
Figure 4.8 c:	<i>Ranking on intellectual property generation</i>	182
Figure 4.8 d:	<i>Ranking on technology management</i>	183
Figure 4.9:	<i>Accessibility to innovative ideas and investments</i>	186
Figure 4.10:	<i>Receptivity to innovative ideas and investments</i>	187
Figure 5.1:	<i>Main support mechanisms of the SPRINT programme</i>	201
Figure 5.2:	<i>Actions 1984/1985 proposed by the Commission and approved by CIT</i>	204
Figure 5.3:	<i>Origin of the network participants</i>	218

<i>Figure 5.4:</i>	<i>Geographical distribution of Specific Projects</i>	226
<i>Figure 5.5:</i>	<i>Annual budgets of major EC RTD programme</i>	227
<i>Figure 6.1:</i>	<i>Distribution of BRITE budget by size of contractor</i>	248
<i>Figure 6.2:</i>	<i>History of BRITE-EURAM</i>	261
<i>Figure 6.3:</i>	<i>Distribution of budget by country</i>	269
<i>Figure 6.4:</i>	<i>Origin of project leaders</i>	272
<i>Figure 6.5:</i>	<i>Most chosen origin by project leaders</i>	273
<i>Figure 6.6:</i>	<i>Number of participants and project leaders per country in BRITE-EURAM I</i>	275

LIST OF ABBREVIATIONS

BRITE	Basic Research for Industrial Technologies for Europe
CEC	Commission of the European Communities
CIT	Committee on Innovation and Technology Transfer
DG	Directorate General
EC	European Communities
ECSC	European Coal and Steel Community
ECU	European Currency Unit
ESPRIT	European Strategic Programme for R&D in Information Technology
EU	European Union
EURAM	European Advanced Materials Research Programme
EURATOM	European Atomic Energy Community
EVCA	European Venture Capital Association
FWP	Framework Programme
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
IRDAC	Industrial R&D Advisory Committee
JNRC	Joint Nuclear Research Centre
LFC	Less Favoured Country
LFR	Less Favoured Region
MECU	Million European Currency Units
OJ	Official Journal of the European Communities
R&D	Research and Development
RTD	Research and Technological Development
SEA	Single European Act
SME	Small and Medium Sized Enterprise
SPRINT	Strategic Programme for Innovation and Technology Transfer
STRIDE	Science and Technology for Regional Innovation and Development in Europe

TAU

Technical Assistance Unit

TII

European Association for the Transfer of Technologies,
Innovation and Industrial Information.

INTRODUCTION

Innovation and technological development are recognised to play a central role in industrial competitiveness and economic growth. Diffusion of innovations and economically useful knowledge is inextricably bound up with this process. Against a background of increased global competition, rising costs for research and development and recession affecting large parts of the world, governments are rethinking their role of how to stimulate innovation in industry. In the past decade the European Community, or the European Union, as it is now called, is playing an increasingly important part in shaping innovation. Its competence and support mechanisms in the policy domain of technological development and innovation have expanded rapidly.

The study in this thesis aims to explore the position of *diffusion oriented support mechanisms in European Community Research and Technological Development (RTD) policy*. This will be studied in the context of a newly emerging concept of innovation, named the integrative approach. The subject is narrowed down to policies towards *industrial* innovation, rather than general research issues. The study sets out to see what are the constraining and facilitating factors to develop a set of policies aimed to support the diffusion of innovations and technological knowledge, at the transnational level of the EC. Thus the impact of such policies in industry is not a central issue in the present study. Nor are a full understanding of the formal and informal procedures of European decision making, a subject of many European policy studies. This study goes beyond that through the combination of understanding the conceptual issues of a particular policy area, i.e. research and technological development (RTD) policy, and setting this area in its political context. Thus the political conflicts in the European Community, often described in very general terms in political theory, are explored here in much greater detail, by looking at the contents of these conflicts in a particular policy area. The main argument in the study is that the levels of conflict in EC

policy making are too complex to allow a diffusion policy from the perspective of an integrative approach to innovation. This challenges the imperative of rational policy making, which assumes an unproblematic implementation of most effective policy instruments.

The study has an interdisciplinary approach: it combines analyses from economic literature on innovation, with that of literature on public innovation policy, at national and particularly EC level. The study is neither a merely 'macro study' in which structural dependencies are the main explanatory factors, nor a micro study in which personal relations are the determinants of the outcome of EC policy making. Its contribution can be placed in the field of 'middle-range' studies, in which policy networks and agents as well as power conflicts are key concepts. It builds on attempts to develop concepts of EC technology policy, in particular Peterson's (1991) conceptualisation of policy networks. Explanations from different angles are combined to assess both the Commission's commitment for and the policy practice of diffusion.

The **first chapter** makes a concise overview of the main lines in the thinking on innovation, summarised in models of the innovation process. It introduces the concept of diffusion in innovation theory and discusses the developments in this thinking, as the theories of the innovation model change. It sets out to show how this change in concepts has not been limited to a community of academic experts, it has been incorporated by policy makers, leading to a shift in public innovation support. What this study aims to show is how this shift in thinking has taken place at Community level.

Chapter 2 investigates the influence of different policy networks and levels of conflicts that shape EC RTD decision making. RTD policy is made within the context of general policy objectives and principles of EC policy. Some of these have a facilitating effect on the development of diffusion oriented policies, others a constraining effect. Peterson's aforementioned conceptual framework is elaborated to increase understanding of the RTD policy. The study analyses

how the competencies and power conflicts between the Commission services shape the development of a diffusion oriented innovation policy.

The **third chapter** examines the influence of past RTD policy on the present position of diffusion oriented policies. The type of research areas and support programmes launched during the last two decades will reveal the dominant trends regarding the approach to innovation and diffusion. This historical perspective allows one to assess if there has been a shift in policy approach in the period since the new innovation approach emerged. The emphasis in this study lies on the period since the early 1980s for two reasons. First this is the period in which a genuine Commission strategy and a significant set of policy instruments for RTD emerged. Secondly it was in this period that the integrative innovation model started to become authoritative among academic innovation experts.

Chapter 4 will look into the question of how diversity in national institutional contexts facilitates or constrains EC diffusion policy to have a European wide impact. The shift in innovation theory as described in the first chapter effects the parameters of comparison between different national innovation capabilities and therefore policy support needs. The differences are analysed from the R&D oriented, the economic and the institutional perspectives. We will discuss if diffusion policies have a better chance to overcome these disparities, compared to the more traditional support mechanisms.

The next two chapters 5 and 6, investigate the implications of the above mentioned shift at the level of EC policy programmes. This allows us to look in greater detail at the operations of the EC support mechanisms. In **chapter 5** the first case study deals with the SPRINT, a programme, aimed to support innovation and technology transfer. This programme is an example of a set of support schemes that has gradually incorporated the notion of diffusion from the perspective of the integrative approach. Its position within the overall RTD policy can illustrate the commitment to diffusion in the Commission. The effectiveness of its support activities reveal how public policy at the Community level can contribute to the diffusion of technologies and the

improvement of innovation capabilities. The other case BRITE/EURAM, discussed in Chapter 6, is an example of one of the 'core' RTD support mechanisms, i.e. a collaborative research programme. This case is chosen in the thesis because, of all major collaborative research programmes, BRITE/EURAM has the best potential to contribute to an industry and Community wide diffusion. Both cases will clarify how the EC can contribute to diffusion policy and what policy considerations influence its status in RTD policy.

The last chapter summarises the discussions of the previous chapters. This allows us to conclude if and how a shift has taken place in EC RTD policy in favour of diffusion oriented policy programmes. This will shed light on the possibilities for an integrative innovation model as the basis for EC RTD policy.

Some clarification on the terminology on the European Community is required. Since november 1993, due to the ratification of the Maastricht Treaty the official name, *European Community* (EC) has been replaced by *European Union* (EU). In addition, the name of the *Commission of the European Communities* (CEC) has been changed into the *European Commission*, causing even more confusion when abbreviated. Since the main part of the discussion in this thesis concerns the period before the Maastricht Treaty, and because of the familiarity of the old name, I have chosen to use European Community (EC) instead of the present name European Union (EU). The Commission will be referred to as the administrative body of both EC and EU.

Sources of information

This study sets out with a literature review discussing the diffusion concept within the innovation process. The aim is not to have a full coverage of all available economic innovation literature, but a selection of those contributions that give an overview of the different perspectives and the evolution of

diffusion concepts. Not only the theories on diffusion are reviewed in this literature section, it also discusses literature on public policy and diffusion. This review forms the basis for defining the key concepts that will be used in the investigations in the rest of the thesis.

The study will concentrate on diffusion policy as a part of the overall Research and Technological Development (RTD) policy of the EC, managed and implemented by the Commission of the European Communities. Policies to improve technical standardisation, which can be regarded as diffusion mechanism, will fall outside the scope of this study, since the focus will be on diffusion linked to other elements of the innovation process such as research and development. Furthermore the focus is on RTD policy for industry.

The empirical analysis of EC policy takes part at three levels:

- the overall RTD policy where decision on priorities and objectives are taken by the Commission of the European Communities, The Council of Ministers, the European Parliament and various committees and lobby agents;
- the level of policy areas in which the various Commission services (in particular the Directorates General) have the largest input in the policy making process;
- the level of programmes and sub-programmes, managed by a particular Commission service, i.e. a separate unit of Community officials.

Chapter 3 which explores the diversity in national systems of innovation makes use of comparative data from secondary sources. Existing statistical data, comparative studies and surveys are used to make a typology of the institutional contexts in the countries of the European Community. The scope of this thesis does not allow for extensive primary data to be gathered and analysed for this purpose.

Sources of information on Commission policies used in this study are numerous. The most significant information can be found in the Official Journal of the European Communities (OJ) and in the so called COM documents from the Commission, which consist of monitoring reports, policy reviews and - most important - proposals for Council legislation. Appendix II gives more detailed information on these sources.

Through contacts at the Commission and with national policy makers, the author gained the information from several undated and unofficial communications. In most cases I have used and quoted the later final version of communications. At the level of programmes, each Commission service publishes a vast amount of reports, varying from promotion leaflets to evaluation reports. Some of these are available through the Office for Official Publications, some are published by the Commission services. Not all of them are properly dated. Further information on the daily practice of European policy making is retrieved from experience on various research and consultancy projects in which the author has been involved.

Additional sources of information on the case studies of chapter 5 and 6 are various documents published by the responsible units: information packages, synopsis of projects, evaluation reports, programme brochures. Furthermore, interviews were made with EC policy makers and experts, involved in overall RTD matters or in the management of the programmes. These interviews were meant to clarify subjects, on which information can not easily be retrieved from written documents. Since sensitive subjects (such as policy conflicts, cohesion) were discussed in the interviews, the respondents preferred not to be quoted directly in the text of the study. This allowed them to speak more freely on the matters in question. The information is used to assist the authors understanding of some aspects of EC policy making. If conclusions could only be drawn from these interviews, this is stated in the text, without a detailed reference to its origin.

1. THE CHANGING ROLE OF DIFFUSION IN MODELS OF INNOVATION AND PUBLIC POLICY

1.1 Introduction

"From the point of view of [invention's] economic impact, it is the diffusion process that is critical. That is because the productivity increasing effects of superior technologies depend upon their utilization in the appropriate places." (Rosenberg 1982:19)

"It scarcely needs saying that the diffusion of innovation plays a pivotal role in the process of technological change, yet it is surprising how little economic policies are explicitly aimed at the promotion of diffusion." (Metcalf, 1990:1)

These two citations typify the problems that will be discussed in this chapter: the diffusion of technological innovations plays a prominent role in the innovation process, an insight that has gained momentum only in recent years. Consequently public innovation policy¹ has neglected this aspect of the innovation process. As stated in the introduction, this study will focus on the position and possibilities for diffusion policies at the European Community level. To understand the concept of diffusion and its place in public policy we will look into its discussion in innovation literature. Paragraph 1.2 discusses the shift in the innovation model in economic literature. This shift in the concept of innovation has its consequences for the perspective of the role of diffusion in that model, which is discussed in paragraph 1.3, on the basis of diffusion literature. Subsequently, we will see how the change in thinking of analysts of the innovation process has influenced the perception of public policy aimed at facilitating both innovation and diffusion and consequently the design of innovation support mechanisms.

¹ Innovation policy is defined as those policies that intend to facilitate the firm's efforts to create, adapt or implement new technological products or processes.

The thinking in literature on the importance of diffusion in the innovation process has achieved greater weight and changed perspective, as we shall see in this chapter. The question under investigation is if we can see a similar trend at the EC policy level. In addition we will investigate what type of diffusion support is targeted: diffusion from the linear approach or diffusion within an integrative approach. This chapters shows that these two have a different impact on the support mechanisms chosen. This study will not give a full account of the extensive literature on the innovation process and technical change². It will discuss the development of main lines of thinking on diffusion and its position in the innovation process in the literature. That implies describing the conceptual development in the reflection on the diffusion process, not on the many empirical studies that have been conducted. Diffusion of technologies has been discussed in literature from various viewpoints: its position in the innovation process, the spatial distribution, its time path and the agents involved.

Rosenberg (1976:189) wrote in 1976 that the serious study of the diffusion of new techniques is an activity no more than fifteen years old. His contributions, which we will discuss below, reflected a turn in the thinking on diffusion. This can only be seen within the framework of innovation theory which evolved in the last two decades.

A fundamental point which this study wants to address is that public policy perception of diffusion is highly dependent on the dominant philosophy on the innovation process as a whole. Therefore before we discuss literature on diffusion itself, the dominant perspective on its position within the innovation process, will be examined.

² For a discussion of the recent developments in innovation literature see OECD, 1992a.

1.2 A shift in the dominant innovation model in literature

"Models that depict innovation as a smooth, well-behaved linear process badly misspecify the nature and direction of the causal factors at work." (Kline/Rosenberg, 1986:275)

In an overview on models of innovation Kline and Rosenberg (1986) state that the generally accepted model of innovation since World War II up to the 1980s, has been what is called the 'linear model'. In the linear model "... one does research, research then leads to development, development to production, and production to marketing" (Kline/Rosenberg, 1986:285). Many contributors on the process of diffusion define its position within this linear model. Davies for instance (1979:1) states that:

"Technological change in the industrial context is often conceived of by economists as comprising three more or less distinct stages. The process is set in motion by an *invention* (or inventions), which may be based on new scientific knowledge or which, more commonly, uses well known scientific principles. The innovation stage occurs when, and if, the invention is first commercially introduced by a firm, often called the innovator. Then, as the new process or product is recognized as superior to competing existing technologies, this results in its further application within the innovating firm and its introduction by other firms in the industry: that is, *imitation* or *diffusion* of the innovation occurs." (Davies, 1979:1)

Innovation is thus perceived as a process with logical and chronological sequences, diffusion being the third and last phase of the process, after first invention and subsequently innovation. It is usually defined as the first commercial introduction on the market. Successful diffusion thus indicates the wide spread adoption of innovations among a population of potential adopters. Nabseth and Ray have described this last stage as follows:

"Thirdly the recognition of the innovation as a more efficient technology results in its further application within the same firm and its introduction to other firms in the industry - that is diffusion." (Nabseth and Ray, 1974:4)

Diffusion is thus a static last phase of the innovation process: the creative mechanisms have already taken place in the former phases. In the linear model the initiator of innovation is science, both at the firm level as at the aggregate level. There are no feedback loops during the process. Soete and Arundel (1993:30) metaphorically compare this model with a pipeline "... because it suggests that an increase in the flow of upstream or supply-side inputs into the pipeline will directly increase the number of new marketable products and processes flowing out the downstream end".

This 'science push' concept of innovation was modified in the late 1960s and early 1970s when authors like Schmookler, (1966) and Utterback (1974) introduced the 'demand-pull' aspects of innovation, in which the market environment is the most important source of innovative inspiration. This broadened the acknowledgement of sources of ideas for innovations, but left the sequential order of the business processes involved in innovation more or less intact. The controversy between demand-pull or science push occupied many scholars in the 1970s. For a review of this discussion we can refer to Mowery and Rosenberg (1979) and Walsh (1984).

In the innovation literature, the dominant linear model is gradually replaced by a much more complex 'integrated model of innovation', mainly under the influence of the so called evolutionary economists whose contributions in literature became more influential from the late 1970s. Important contributions came from Nelson and Winter (1977 and 1982), Dosi (1982) and Dosi et al. (1988), Freeman (1982), Freeman and Perez (1986) and Rosenberg (1976).

The general set of theories that derived from the new evolutionary line of thought, have wide implications for the concept of diffusion, which now forms a part of the dynamic innovation process, a process of continuous 'creative destruction'. The evolution of technology moves along natural technological trajectories, where there is a constant rivalry among technological alternatives.

Diffusion is one of the stages in this process where the market enters to select the innovations and 'winning solutions' (Cainarca et al., 1989:61). This selection process is not straightforward: the technology will undergo incremental innovations during the whole diffusion process. Besides it will not necessarily be the best performing technology that finds widest diffusion. Powerful market strategies of oligopolistic companies or government interventions can lead to the diffusion of 'sub-optimal' technologies (Jacobs, 1990).

The cumulative aspect of innovation is another important feature in the evolutionary philosophy. Rosenberg (1976) and Pavitt (1984) stress that in making choices about which innovations to develop and produce, firms are constrained in their search by their existing range of knowledge and skills to closely relate zones. What they can realistically try to do technically in the future is strongly conditioned by what they have done in the past.

Inspired by this new line of thought Rothwell and Zegveld (1985) have put forward that the traditional linear models of innovations, with clearly defined and chronological phases, are over-simplified. Both the 'technology push' model and the 'demand-pull' model are not capable of understanding the full process of innovation. "In the first case, it is obvious that more R&D has not necessarily resulted in more innovation. In the second case, overemphasis on market needs can result in a regime of technological incrementalism and lack of radical innovation (...). Moreover the relative importance of technology push and need pull might vary considerably during different phases of the industry cycle" (Rothwell/Zegveld, 1985:50). The authors present instead the 'interactive model'. According to this model innovation is regarded as a logically sequential, though not necessarily continuous process, that can be subdivided into a series of functionally separate but interacting and interdependent stages.

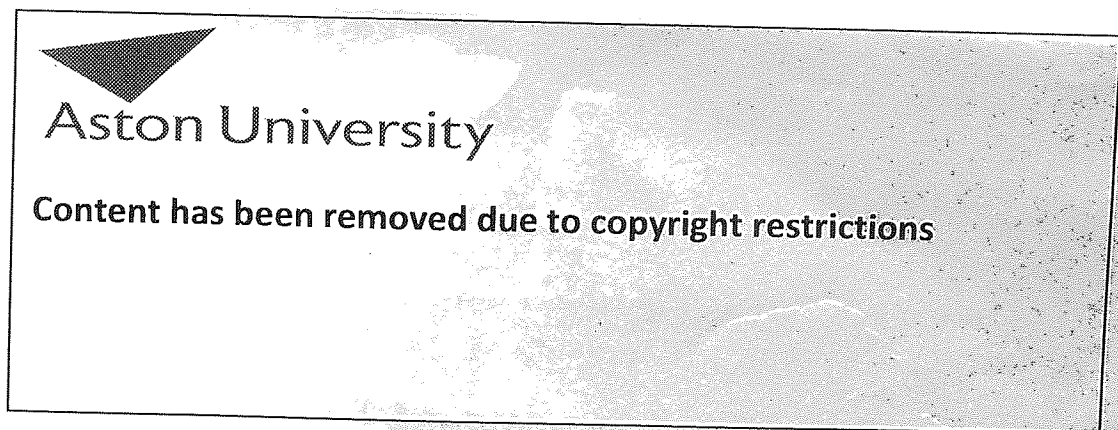
Although this model allows for various sources of innovation, the main pattern is still a process of sequential, separate steps. The conceptualisation of

innovation with strict distinctions between invention, innovation and imitation has been sharply criticised by Nathan Rosenberg. He blames this to the 'Schumpeterian heritage' who was concerned to focus attention upon the circumstances surrounding the act of innovation and the role of the entrepreneur in this (Rosenberg, 1976:67):

"The consequence of this sequential isolation of invention and rigid segregation of the technological and economic realms is the failure to exploit technological factors in furthering our understanding of innovation and diffusion." (Rosenberg, 1976:68)

"(...) as a result, the analysis of the diffusion process fails to focus upon continued technological and engineering alterations and adaptations, the cumulative effects of which decisively influence the volume and the timing of the product's sale." (Rosenberg, 1976:75)

Figure 1.1: Interactive model of the innovation process



Rosenberg posits that there is a creative process in diffusion and that it is difficult to define a clear cut post-innovative phase. Even incremental innovations as opposed to radical innovations are economically speaking very significant.

The interactive model presented by Rothwell and Zegveld was soon to be modified with the introduction of the chain linked model by Kline and Rosenberg (1986). The authors point to the severe shortcomings of the traditional model as discussed above. They stress that innovation is controlled by two set of forces: market forces on the one hand and technological and scientific barriers on the other hand. "Successful innovation requires a design that balances the requirements of the new product and its manufacturing processes, the market needs, and the need to maintain an organization that can support all these activities effectively" (Kline/Rosenberg, 1986:277). This implies that R&D conducted in isolation of market needs will not necessarily be economically useful.

In the Kline/Rosenberg model (figure 1.2) there is a continuing interaction and feedback between the phases and elements of the innovation process. The central-chain-of- innovation lies within the firm. Furthermore it shows the interaction between the firm and the wider technology and science system. The interactions between science and technology are strong and extend all throughout the innovation process, to be used when needed. However, science or even research is not the main source or initiator of innovation: in this model design and design related research is the linchpin of innovation. Particularly 'analytical design', defined as the analysis of various arrangements of existing components or of modifications of designs already within the state of the art to accomplish new tasks or to accomplish old tasks more effectively or at lower costs, is the major initiator in the innovation model. The effect is the blurring of the borderlines between basic research, applied research and product development.

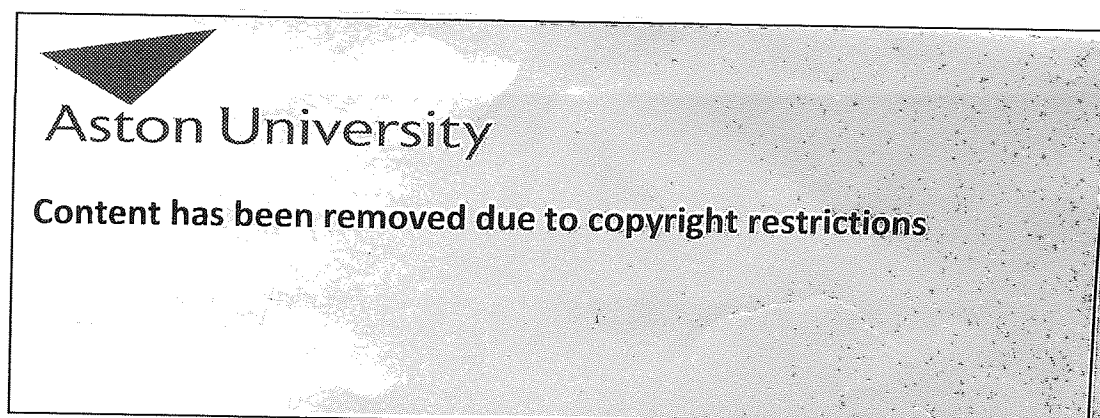
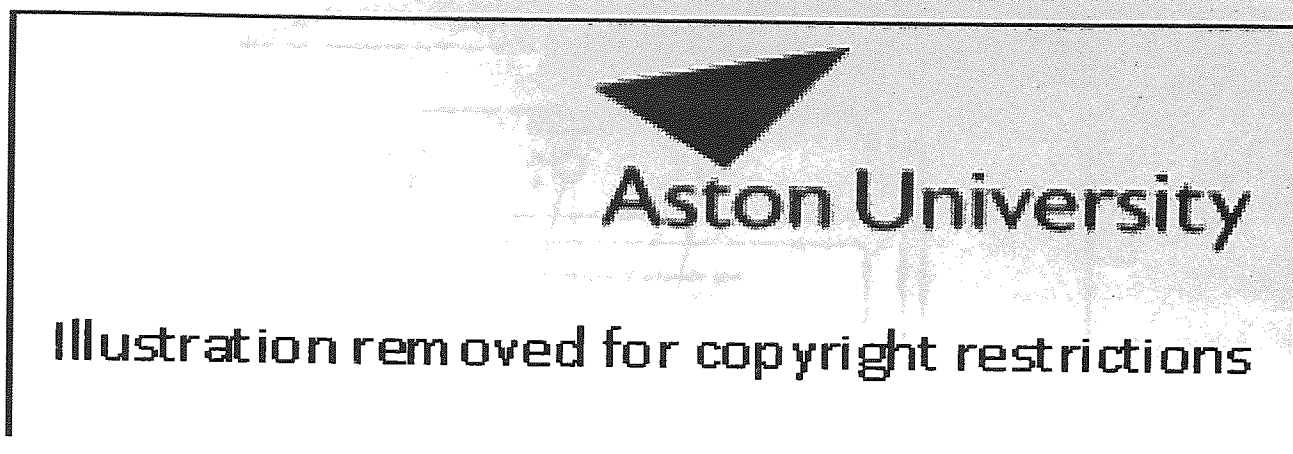
A shortcoming of the Kline/Rosenberg model is the tendency to focus on the technological aspects of innovation. It neglects the many organisational, social and managerial capacities that are needed for successful innovations. Furthermore, one should avoid to depict the firm as an isolated economic actor in this process. For instance the effectiveness of links with the research and knowledge base is very much based on the firm's networking capacity, not only with the research community, but equally important with other firms that could provide the necessary knowledge. Keith Pavitt (1984) has shown the importance of other firms and industries as the sources of innovation in some sectors of industry. Especially the supplier-dominated firms rely on other firms to provide them with innovated equipment and materials.

Freeman and Perez refer to the importance of clusters of related innovations: the interaction between the suppliers and adopters of innovation will induce the expansion of new capacities and skills necessary to sustain a rapid adoption process (Freeman/Perez, 1986). More research has pointed to the importance of interrelatedness and associated complementarities between industries to enhance innovation and diffusion (OECD, 1992, Porter, 1990). Related industries can create new technologies by combining the previously distinct knowledge.

A concise description of the change in thinking about the innovation process can be found in the OECD report *Technology and the Economy, The key relationships* (1992).

"Today however, the innovation process has finally come to be recognised as characterised by continuing interaction and feedback. Interactive models diverge significantly from their linear approach. They generally emphasise the central role of design, the feedback effects between the downstream and upstream phases of the earlier linear model and the numerous interactions between science, technology and the process of innovation in every phase of the process." (OECD, 1992:26)

Figure 1.2: An interactive model of the innovation process
The chain linked model



Source: Copy from OECD, 1992:25, Adapted with minor changes from Kline and Rosenberg (1986)

The integrated model has also led to a change of thinking about the role of diffusion. No longer does it refer solely to the spread of homogeneous technical artifacts, it is part of the innovation process as a source of mainly incremental innovations. Diffusion as defined as the spread of innovations into the markets is not mentioned as a separate element in the integrative model. It is an activity integrated in the innovation process, as part of redesign and distribution to the market. Diffusion capabilities affect organizational learning of firms and institutions, which is an essential feature of the innovation process. It increases the accumulated knowledge available to all actors involved.

Does this mean that diffusion does not actually exist? Is it invisibly integrated into the innovation process in such a way that it is not appropriate to discuss it as a separate process? I would state that both for understanding the innovation processes in different types of industry and as a basis for policy formulation we should still distinguish between those innovation processes where radical innovations which rely heavily on scientific research and knowledge are needed and those where the emphasis is on redesign on the basis of existing technologies and knowledge. Even if we step down from the traditional linear model to an integrative model of the innovation process, we can still distinguish its elements (Hilpert, 1991 Nelson, 1993). And although diffusion is an integrated part of the innovation process it is mainly situated in the redesign phase of this process.

1.3 The evolution of the innovation model: consequences for diffusion theory

Before we continue to explore the consequences of the shift in thinking for diffusion theory, we should first discuss the current studies and contributions on diffusion. I have chosen not to give a complete account of the studies, but rather concentrate on contributions that explore the conceptual framework of diffusion and its relation with innovation.

The foundations for studies on diffusion were laid in the sixties and seventies, long before the evolution towards a new innovation model took off. It is not surprising that in the 1960s and 1970s the majority of contributions on diffusion are still very much influenced by the linear approach.

Lawrence Brown (1981) has made a comprehensive historical overview of diffusion studies in his book *Innovation Diffusion*. He distinguishes the adoption perspective, the market and infrastructure perspective, the development perspective and the economic history perspective.

The *adoption perspective* which is the most dominant and most completely developed area of research, focuses upon the demand aspect of diffusion: when does adoption of an innovation occur. "Until recently, in fact, the adoption perspective was coincident with what people referred to as innovation research" (Brown, 1981:5).

In the 'traditional' empirical studies on diffusion the object of study most often is the time path between an invention, the first successful market introduction and/or the full spread on the market of an innovation. These studies try to establish the rate and speed of diffusion of a particular case of technology, mainly process innovations in a very particular industry, and look for the explanation of the underlying factors. There is a strong contribution from the field of geography, which shows interest in the spatial spread of innovations after invention or first market introduction. The adoption of an innovation is primarily the outcome of a learning or communication process. Therefore explanations for non-adoption or a low diffusion are sought in ineffective flows of information or resistance to adoption by the potential adopters. This behaviouristic approach looks at the users and potential users of innovations. With mathematical techniques the probability of potential adopters at time $T + 1$ is calculated, adding variables as income, information increases and firm size. Theories and studies on inter-firm diffusion in this tradition depend

heavily on the mathematical theory of epidemics of diseases (Soete, 1984, Brown, 1981).

Severe criticism on these type of studies was made by Gold (1981) especially on those scholars that criticized industrial managers for delays in adopting seemingly relevant - evaluated with hindsight - technological innovations.

"Indeed it is of fundamental importance to recognize that virtually all innovations involve technological and economical risks at all stages of diffusion and that decisions to reject may accordingly be entirely justifiable at any stage by some prospective adopters." (Gold, 1981:265)

The key object in studies from the adoption perspective, is the decision making process at the firm level to adopt or not adopt an innovation. The diffusion rates in industry are determined by the decisions of managers. Gold (1981), who is very critical at the level of foregoing research on diffusion up to the early eighties, made some important observations of the research on this decision making process. The almost universal acceptance of profitability expectations as the key explanation to diffusion rate, is discarded as a tautology since firms are profit-seeking organisations. Most research is based on post adoption investigation of the decision making process - mainly of successful innovations -, whereas much more valuable information would be obtained from the 'pre-decision' environment and from non-adoption decisions, according to Gold. Furthermore decisions to adopt are taken on a much wider set of considerations than profitability explanations alone.

"Indeed our detailed intraplant studies suggest that a surprisingly high frequency of technological adoption decisions seem to be based essentially on engineering evaluations of expected physical input-output improvements with parallel economic benefits simply being assumed." (Gold, 1981:259)

Gold considers a major flaw of the adoption perspective is that they fail to recognise that differences in diffusion rates among innovations and industries

could be due to changes in the innovations themselves rather differences in adopters. Most traditional diffusion studies reveal a static concept of innovation, neglecting the significance of improvements after the first introduction. "Rapid technological changes may actually inhibit diffusion rates as prospective adopters seek to avoid forms of innovation which may be superseded before long" (Gold, 1981:248).

The second approach that Brown distinguished in his review, *the market and infrastructure perspective*, looks rather at the supply aspect of diffusion. Whereas the adoption perspective:

"(...) implicitly assumes that all have an equal opportunity to adopt and focuses therefore upon individual characteristics to explain differences in the actual times of adoption. By contrast, the market and infrastructure perspective (...) takes the stance that the opportunity to adopt is egregiously and in many cases purposely unequal." (Brown, 1981:7)

A key role in this framework is played by the diffusion agency - or agent - that distributes the innovation. This can be either a public or private sector entity. The first stage of the diffusion process consists of diffusion agency establishment. Subsequently the diffusion agency conceives and implements a strategy to promote adoption among its target group, thus a marketing strategy for the innovation. Finally in the third stage of diffusion adoption occurs. Brown's treatment of the concept of diffusion agency is very general and abstract. It varies from sales outlets to birth control centres. An important issue raised by Brown concerns the establishment of networks of these agencies by public authorities. It requires choosing whether to create a new network of diffusion agencies or to utilize already existing infrastructures. This issue will be discussed below when it concerns European wide diffusion networks set up by the Commission. Again Brown's discussion of the topic, assumes the innovation to be a ready-made artefact that only needs to be marketed properly by the organisations that supply the innovation.

The *development perspective* that Brown introduces looks at the impact of diffusion and ways in which diffusion is affected by aspects of the overall level of development. Contributions from this perspective mainly look at the aspects of diffusion towards the Third World. Since this study is concerned with diffusion among industrialised countries in the European Community we will not elaborate on this perspective.

Finally the *economic history perspective* posits that diffusion is part of a continuous process of innovation, where innovations are not static artifacts but change in form and function including the environment into which it might be adopted. The innovations undergo continuous technological improvements and adaptations to the market (Brown, 1981) This continuity also affects the adoption decision. Rosenberg (1976) found that there is often a delay in adoption solely because of the expectation of further improvements in the innovation. Potential adopters will postpone their purchase because the innovation will be better and maybe even cheaper tomorrow. The contributors in this tradition reinterpreted much of the earlier historic work on innovation which focused entirely on the technological aspects. Instead they added the economic dimension of both technical change and diffusion. In addition this economic history perspective has a concern for the institutional factors involved in innovation.

It is this last more dynamic perspective which makes the conceptual link to the integrative approach to innovation most smoothly. Authors in this tradition link diffusion to the life cycles of product and process innovations and consider diffusion as a stage in the complex sequence of technological change. In the traditional approach this is as we have seen the last stage. With the evolution of the innovation model the position of diffusion becomes less obvious in terms of sequence in the innovation model.

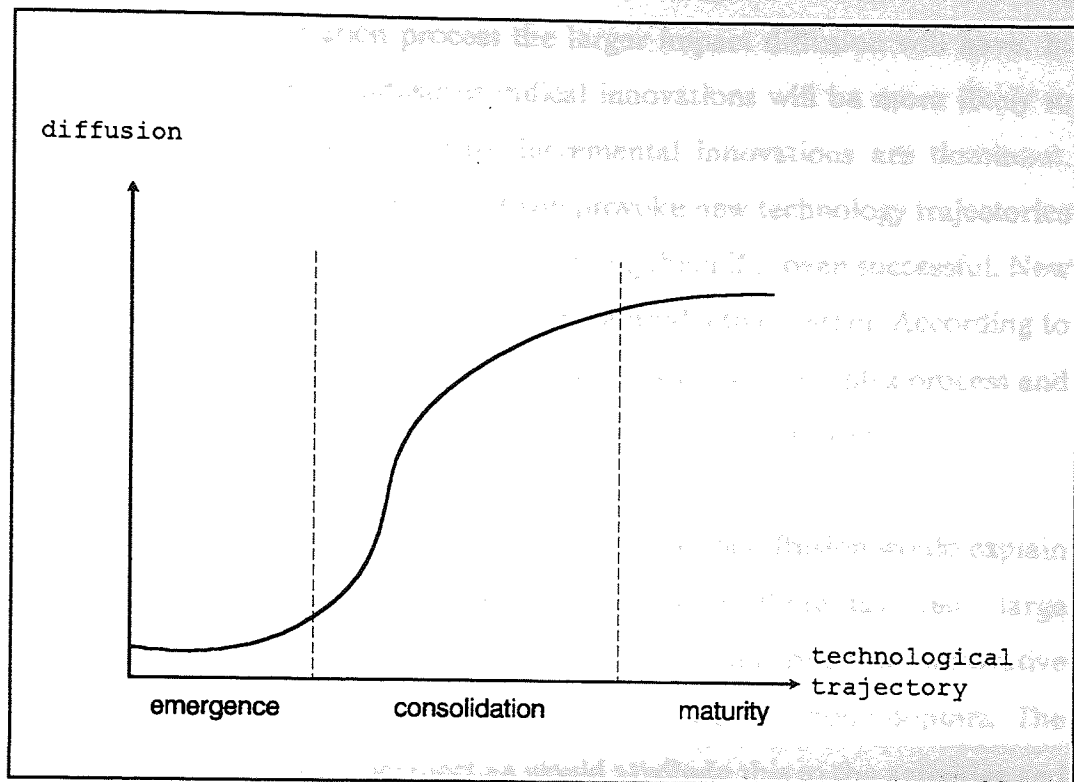
1.3.1 The time paths of diffusion

An element in the thinking of diffusion is to link the concept to its time paths. This allows to differentiate the importance of diffusion for different types of industry, depending on the life-cycles of their products. It also reveals a distinction between diffusion of end products or processes.

In the literature on the diffusion process there is considerable agreement about the time pattern (speed and rate) of diffusion, which may be expected following the first introduction of a new technique (or innovation). This parallel pattern is a S-shaped curve (see Nabseth and Ray, 1974:8-9; Brown, 1981:20 -22; Metcalfe, 1990:9; Jacobs, 1990:11-14). This S-curve is strongly linked to concepts of technological phases: different types of phases used in the innovation literature are combined with each other: product life cycles and industrial life cycles. "The S-shaped diffusion pattern is in many ways rather similar to the industrial growth pattern of industries depicted by Schumpeter (...)" (Soete, 1984:323).

The following picture, taken from Ergas (1986:49) links diffusion with the concept of a technology trajectory defined as a path of technological development, drawing on a given set of basic scientific principles and propelled by an internal dynamic of improving performance in terms of a few key design criteria (see for further elaboration Nelson and Winter, 1982; Rosenberg, 1976; Dosi, 1982).

Figure 1.3: Rate of improvement in terms of key design parameters



In the first stage the *emergence* phase (E) experimentation takes place with alternative design approaches "as attempts are made to identify those with the greatest promise for subsequent development". The second *consolidation* phase (C) the demand for the innovation increases. "(...) concentration of R&D on a few critical parameters, within the framework of a broadly set design approach, allows rapid improvements both in performance and in cost" (Ergas, 1986:48). The last phase is the maturity phase (M) where there is more rivalry from alternative technologies as substitutes for the innovation of which the most easily exploited opportunities have been fully utilized. Kline and Rosenberg (1986) relate these phases to different degrees of uncertainty, conceptualized as a spectrum between revolutionary and evolutionary innovations. It effects whether a firm can rely on existing knowledge or has to pursue new knowledge through scientific research. Freeman and Perez (1986) make a distinction between four types of innovation and their diffusion

processes: incremental innovations, radical innovations, new technological systems and changes in the 'techno-economic paradigm'. The more radical and far reaching the innovation process the larger impact diffusion will have. In the emergence phase of industries radical innovations will be more likely to occur, while at the maturity phase incremental innovations are dominant. Changes in the technological systems will provoke new technology trajectories alongside the existing ones, gradually replacing them if proven successful. New paradigms bring a restructuring of the whole productive system. According to Freeman and Perez, diffusion of paradigms is a slow and complex process and very uneven between countries and different industrial sectors.

Brown shows how each of the different perspectives of diffusion would explain the flatness of the S-curve's left tail, the period before there has been a large *bandwagon* effect. The adoption perspective would refer to innovative characteristics of adopters or resistance to adoption by non-adopters. The market and infrastructure perspective would attribute this to the activities and strategies of the diffusion agencies "pertaining to the establishment of diffusion agencies, pricing, infrastructure and organisational development, promotional communications, and market selection and segmentation" (Brown, 1981:284-285). Researchers looking at the rate of diffusion among firms would use profitability conditions as explanation. And finally the economic historian, (or the evolutionary economist), would argue that the slow initial rate of diffusion reflects the time needed to improve the innovation and adapt it to a variety of potential users, as well as delays because such improvements are anticipated.

Nabseth and Ray (1974; Ray, 1989) show, from a longitudinal study of major innovations from 1967 to 1986, that S-shaped route from introduction to saturation is irregular and its shape is different for each technology and each country. The technologies they chose to follow up were all process innovations with a high degree of 'readiness'. As we have seen above, their notion of the

stages of technological change is however a very linear one, from research leading to an invention and subsequently a new product. Using the life-cycle approach to single products risks oversimplifying the sequences of the process.

Connecting the notion of diffusion with industry life-cycles does give us insight in the differences between industrial sectors. Diffusion has an effect on the innovation capacity of firms since it influences the aggregate level of knowledge available to firms. Emerging industries depend much more on technologies that are at the start of their trajectory, where changes depend on radical innovations based on research and development. Uncertainties what the leading technologies will be makes that firms make efforts in creating new knowledge in alternative technology areas. The aggregate level of knowledge is not well established yet. Diffusion in these industries includes mainly obtaining (research-based) knowledge from adjacent sectors. 'Analytical design' as introduced before plays a major role. Industries in the consolidation phase use and create technologies of which design parameters are more pronounced. Their innovations stem from improvements in performance and costs or new combinations with existing technologies in other fields. Their concern with diffusion concentrates on the application of these 'proven' technologies in new type of products or processes. Mature industries' main drive for innovation is competition from alternative technologies or from competitors in other regions that can produce their products at lower cost. Their concern is to find alternative value added products, often based on non-technological innovations, or production processes that are more cost effective. Diffusion of technologies for process innovations are particularly important for these industries. So diffusion has a different content for industries in different stages of development. Public policies would have to take into account what instruments suits which type of industry.

To summarise, two related assumptions are often found in diffusion literature that obscure a better understanding of the diffusion process.

The first one is that the innovation to be diffused is a ready-made product that does not undergo changes during the distribution process itself.

"In most studies a technology is equated with given and unchanging artifacts, either products or the machines or materials with which they are produced, and this has been a dominant approach ever since the pioneering work of Griliches (1959) and Mansfield (1961)." (Metcalf, 1990:5)

As we have seen above, first the economic history perspective and particularly the evolutionary theories have shown the misconception in this assumption. With the emergence of the integrative model of innovation, diffusion has become an incorporated element in the innovation process.

The second assumption is that diffusion only involves the distribution of technological artefact, regardless of the environment in which it is applied. This would imply that any technology can be transferred to other firms or industries without major implementation problems.

More recent contributions to the discussion stress the importance of a broad approach to diffusion. Successful diffusion also depends on (changes in) the 'environment' of the technology as for instance the availability and adaption of human and financial resources, the necessary embedded knowledge, the integration of new technologies in the organisation, changes in the relationship with suppliers, to name just a few. As Gold has shown, non adoption can be very rational and many of the grounds can be found in these 'contextual' factors.

"Even if the conditions are favourable for the investment in capital embodying new technologies, firms may be reluctant to make the investment if their work-force is not equipped to handle the new products. Hence the institutional arrangements that produce skill in a country - both public and private - become an important element in the diffusion process" (OECD,

1991:45). This aspect of diffusion is referred to as diffusion of best social practice (Jacobs, 1990:43-51). "Technology strategies that are tightly integrated with the manufacturing work force, the organisational design, and human resource practices work far better" (Jacobs, 1990:46).

Metcalf, who embraces this broad view, sees diffusion of technology as streams or trajectories of related improvements rather than as single innovations. Two dimensions deserve close attention:

"The first is technology as sets of skills embodied in individuals and shaped into competencies within organisations. This is technology as the ability to act, the ability to perform productive transformations. How skills are acquired and articulated is surely vital to the study of technology diffusion and indeed, is often captured explicitly in the literature on technology transfer. The second dimension of technology to emphasis is technology as knowledge, the ability to think about and explain the transformation process in terms of facts, concepts and theories." (Metcalf, 1990:5)

"Diffusion involves investment in skills and knowledge as well as investment in material artifacts. ... what is being diffused is not a single artefact but rather a sequence of artifacts or post innovation improvements (...) as the original design is enhanced and extended to new applications." (Metcalf, 1990:6)

The most recent and systematic contribution on diffusion can be found in the OECD report *Technology and the Economy, The key relationships* (1992). In this study a distinction is made between disembodied technology diffusion and equipment-embodied diffusion. Disembodied diffusion, has two elements, 'research spillover' and the 'absorptive capacity' of firms. Research spillover refers to knowledge developed by one firm becoming potentially available to others. There are several mechanisms through which research information flows outside the originating firm: research personnel is the main one. Absorptive capacity refers to the ability of firms to learn to use technology developed elsewhere (OECD, 1992:47). The ease at which firms learn to absorb is also dependent on their own R&D efforts: it helps the firm to be in touch with available knowledge, reinforces the links with external sources of

knowledge, in short 'learning by learning'. Networks, both formal and informal are an important mechanism for firms to have access to publicly available knowledge. This again illustrates the integrative character of the innovation process. The more traditional approach to diffusion as we have seen in the discussion of the adoption perspective looks at equipment-embodied diffusion. Here a few industries are suppliers of technology-intensive goods and components to the downstream industries that can choose to buy them. There are early adopters who take the risk of using the new technologies before they have widely proven to have economic benefit. They create a 'critical mass', a gauge by which late adopters can judge the benefits of adoption. The discussion on the motives and conditions for adoption is summarised in the TEP report (OECD,1992:55-58). In short the real or perceived pressures of competition and the relative advantages of using competing technologies affect the pace of investment and adoption of new technologies.

In innovation literature many authors refer to technology transfer when they discuss the spread of knowledge or innovations from one actor to another. There is a large degree of overlap in the conceptions of diffusion and technology transfer, which needs to be clarified. In the history of studies on technology transfer, several broad subjects are covered. Firstly the study of transfer of technologies from developed countries to less developed countries (either being north - south or west - east flows) and their impacts on the receiving societies. A second area of study is the transfer of technologies coming from multinational enterprises to their multinational environments. The third area of research, the one that is most relevant for this thesis, examines the significance of technology transfer to improve competitiveness of firms, industries and economies.

A comprehensive study of this third area has been made by Charles and Howells (1992). They define technology transfer in much a similar way as diffusion has been described:

"Technology transfer can be described as the diffusion of the complex bundle of knowledge which surrounds a level and type of technology. (...) It includes 'embodied' knowledge (in physical products, plant and equipment) and 'disembodied' knowledge (know-how, information, patents and learning), and the flow of information and knowledge at a micro and macro-level between individuals, organisations and economies." (Charles and Howells, 1992:3)

The exact boundaries between the two concepts are not clearcut. Diffusion is commonly referred to as the exchange of innovations between firms, whereas technology transfer concentrates on the phase where knowledge is exchanged between research organisations and firms. Studies on technology transfer either discuss industry-research links or the exchange of licensed technologies between firms. This study considers diffusion as a wider concept, of which technology transfer is a part. Since this thesis will address a broad range of processes the choice is made to use the concept diffusion.

What can we conclude from the literature regarding diffusion?

- innovation is a continuous process with diffusion as one of its aspects, difficult to isolate as a separate sequence because of the ongoing process of incremental innovations in finding new applications for existing technologies;
- diffusion can not be considered separately from its organisational and social context: it is a learning process;
- diffusion is different for each industry, country and technology.

Both the dynamic integrative approach - considering innovation and diffusion as a continuous and simultaneous process - and the 'learning process' perspective - which sees diffusion as a much wider concept than concerning only technological artifacts - are important improvements in the understanding of innovation and diffusion. These concepts will act as an important touchstone in assessing the EC technology policies in the coming chapters of this study.

1.3.2 Defining diffusion

The definitions of diffusion in literature vary with the perspectives as described by Brown. A very general definition of diffusion is given by Rogers:

"Diffusion is the process by which an innovation is communicated through certain channels and over time among the members of a social system." (Rogers, 1983:5)

Rogers looks at diffusion from a communication perspective: diffusion rates are determined by flows of information and communication. Diffusion in this line of thought deals with 'ready made' innovations and thus separated from the creative process of technological change.

Others stress the distributional characteristics of the diffusion process:

"Mansfield, whose contributions have dominated this area of research, conceives of a three way definition: *imitation* or *inter-firm diffusion* refers to the spread of the new processes from firm to firm within any industry; *intra-firm* diffusion to the spread of the process within individual firms and *overall diffusion* to the spread throughout the industry as a whole." (Davies, 1979:6)

Another definition which shows a mainly spatial interest in diffusion is from Brown:

".. the distributional characteristics associated with innovation are also important for study. These characteristics change over time, rather than remaining static, and the process by which such change occurs, that is, by which innovations spread from one locale or one social group to another, is called *diffusion*." (Brown, 1981:1)

Finally the OECD/TEP report of 1992 states that the notion of diffusion must be taken to include adoption by other users as well as more extensive use by the original innovator. "More generally it encompasses all those actions at the level of the firm or organisation taken to exploit the economic benefits of the

innovation" (OECD, 1992:48). This is a very wide definition which would also include marketing and sales efforts.

Incorporating both the integrative approach and the 'learning process' perspective, I will use the following definitions:

Diffusion is that part of the innovation process where technologies that have reached beyond the point of design and (prototype) manufacturing and had their first encounter with commercial introduction in the market, spread throughout industry, going through a process of redevelopment and redesign, not necessarily by the originating innovator, to improve its performance or costs, or change its application for the purpose of (potential) users.

The spread of homogenous 'off-the-shelf' technologies, will be referred to as technology dissemination.

This definition emphasises the supply side of diffusion more than the adopting side. It allows a wider use and understanding of the concept of diffusion. It comprises both vertical diffusion - between the knowledge and research base (within or outside the organisation of the firm) and the firm's business processes - and horizontal diffusion between different firms. The redesign of existing industrial technologies, for instance a new design of CAD/CAM systems into a cross-sector application, can be seen as a form of diffusion of technology.

It also allows for a wider understanding of *diffusion capabilities* on the one hand and *dissemination capabilities* on the other hand. For instance the capability of firms to implement existing process technologies into their manufacturing process would imply certain diffusion capabilities if this process-technology is to be adapted to the specific requirements of the firm. This could be either the capability to redesign the technology internally or a 'network-management' capacity to co-operate with the appropriate supplier to

perform the redesign. If the process technology can be bought and ready implemented, the main capability needed is finding access to information on available technologies. Therefore the main policy issue for dissemination is improving channels of information and communication.

1.4 *Diffusion as a policy concern*

"... Long-term growth mainly depends on the capacity to deploy technological capabilities across a broad range of economic activities. In this sense, the major problem of technology policy (as distinguished from science policy) lies less in generating new ideas than in ensuring that they are effectively utilized." (Ergas, 1986:11)

Diffusion oriented policy is not only a neglected public policy area, it has been a controversial one as well. Paul David (1986:373) blames this on a lack of systematic vision:

"By failing to address systematically the issues concerning diffusion in our national policy discussions, we have surrendered the opportunity to see whether it is possible to formulate any consistent set of goals, or to coordinate the actions of the many public agencies that are engaged in the de facto setting of policies affecting the development of our technological capabilities."

Diffusion policy is a neglected area in the same sense as it is disregarded in innovation theory: the focus has traditionally been on the 'upstream', science oriented phases of innovation. Public policy was dominated by the traditional linear stage model of innovation, in which innovations originate from (basic) research leading to inventive ideas and subsequently to further development in production and finally to marketing. The basic assumption was that if governments would increase the effort in research, more innovations and marketable products would subsequently follow, as if the innovation process were a pipeline.

Therefore the dominant type of science and technology policies in most OECD nations, were those that actively supported R&D investment by firms, together with a large effort to perform R&D in government supported organisations as research laboratories and universities.

This perspective of enhancing technological innovation has also been described as the 'technology push model'. In terms of broad trends in public policy, this model was the main outlook in the 1950s and 1960s (Rothwell/Dodgson, 1990; Rothwell/Zegveld, 1985).

When diffusion entered in the political debate, there were many constraints to actually implement policy instruments for its support. One of these constraints is the discussion on the role of government regulation in industry. The discussion among academics and policy makers focuses on the question whether governments should be engaged in the 'near-to-market' part of the innovation process. There is widespread consensus that governments have a role to play with respect to basic research, for instance through university or defence related research and even through subsidising private research. Indeed even applied industrial research, is in many countries an accepted domain of public policy. The closer government actions get to market introduction of innovative products or processes, the more controversial its role becomes. In many countries liberal oriented policy-makers state that government action in the downstream phases is an interference in the competition between firms since it involves near-market technologies. In this line of thought any action beyond the research stage would interfere with market relations. Only if it concerns technologies with a 'societal' or strategic purpose, there is less resistance against government actions in that field. Examples are energy or environment related innovations. For each country the style and boundaries of government regulation are different, depending on institutional traditions and the political colour of the governments in office.

We have already seen that if we acknowledge the importance of diffusion in the innovation process, regulation would expand to other business functions,

related to (re)design of new applications of existing technologies. Furthermore if public policy aims to enhance industrial competitiveness, improving the absorptive capacity of firms, the non-technological aspects of innovation should be supported simultaneously, especially if there is a concern for the innovation of SMEs. Their innovation efforts are usually focused on the downstream stages, where the design of new applications of existing or enabling technologies is the mission. Apart from the technological barriers to innovation, some have suggested that management of innovation is an even larger impediment (ING- Bank, 1994). This asks for even more government involvement in the business processes of individual firms. The focus of this thesis is to study the political commitment for this type of regulation at EC level. In chapter 2 we will come back to this question. For a better understanding we will first look at the contributions on these issues at the national level.

Some experts on innovation policy have stated that the univocal picture of a 'science dominated' policy at the national level has changed its character over the last two decades. The early 1970s saw the start of a broader type of innovation policy where demand-side factors play a larger role. Rothwell and Dodgson (1990) observe an increasing interest in SMEs in the mid 1970s early 1980s and measures to support their innovation. However in the mid 1980s the attention shifts to the support of strategic technologies, in particular information technology and bio-technology.

"Technology policy arose in response to the announcement by Japan of its Fifth Generation Computer Technology Development Project in 1981: it involved the initiation of major national technology programmes in information technology..." (Rothwell/Dodgson, 1990:8)

It also triggered the launch of the first major EC R&D programme: ESPRIT. This programme clearly designed from the perspective of the linear stage

model of innovation, supports 'upstream' pre-competitive research in the R&D

laboratories of Europe's large electronics companies. We will discuss this in greater detail in the next chapter.

The dominance of the linear model does not imply that there were no diffusion oriented initiatives. Brown (1981) describes the initiatives in the US in the sixties and seventies, but criticises them for their shortcomings. The author sees an increasing awareness of the shortcomings of diffusion support amongst public policy practitioners, congruent with the evolution in diffusion theory. As the dominant theoretical approach has for a long time been the adoption perspective, so were the policy approaches. According to Brown the first generation public policy programmes for diffusion focused on the adoption perspective: potential users can be persuaded to adopt certain technologies. The emphasis was on the communication aspect of diffusion: public programmes were aimed at information and guidance for potential adopters (Brown, 1981:288).

In this narrow perspective formal programmes are directed toward encouraging the wider application of a specific new technology in the economy. These early generation programmes were again designed from this same linear perspective: diffusion as the last phase of innovation, which only needed spreading the information on new technologies. The most familiar recent examples are programmes to stimulate the use of computers or micro electronics by consumers and firms, either by the actual spread of them - for instance Minitel in France - or by means of tax reduction schemes. Similar policies are the technology transfer programmes aimed at introducing certain - mainly agricultural - technologies in Third World countries.

This prevalence of the adoption perspective has been severely criticised for placing the responsibility for non-adoption solely on the potential adopters without being critical to the role of the diffusion agent. Brown argues that policies should have a broader outlook and include the market and infrastructure perspective as well as the economic history perspective in the design of policy

programmes. With the first, diffusion will be placed in a wider social, economic, political and psychological context and becomes a problem in logistics, distribution and promotion instead of consumer behaviour (Brown, 1981:289). Support activities will put the emphasis on stimulating demand for the innovation and making it available and accessible to the potential adopter. Responsibility for non-adoption or low levels of diffusion will be shifted to the diffusion agents and government. Including the economic history perspective in policy design options, will diminish the strict separation of diffusion from the research and development efforts and add a dynamic dimension.

Changes in the thinking on innovation and diffusion as described above influenced policy makers in two ways:

- firstly awareness grew that not only the research elements were a factor of successful innovation support, the diffusion of technologies and technological knowledge were as important to turn innovations into successful commercial products and processes and thus improve competitiveness;
- secondly awareness grew that diffusion contains more than the dissemination of ready-made artifacts. For firms engaged in the development of new technologies, diffusion is an element which should be addressed in an early stage of the innovation process. For firms that are mainly recipient of innovations, their absorptive capacity is at stake.

From the 1970s to the 1990s, policy-makers' and analysts' reflections on diffusion support mechanisms went through two changes. Firstly there was recognition of the fact that diffusion, in terms of the spread technologies throughout the industrial fabric, should be supported to speed up the innovation process in different industries. The main support task that was to be developed for this purpose was an improved spread of information on innovations and research findings. This change in philosophy was still compatible with a linear approach of innovation: invention, innovation and

diffusion are separate operations. The second and later change in philosophy coincides with the emergence of the integrative approach to innovation. An awareness grew that diffusion is more complex and comprehensive than assigned in the linear model. Thus public support for diffusion requires a different role as well.

One of the first authors to elaborate comprehensively on diffusion policy issues is Henry Ergas (1986). In his publication "Does Technology Policy Matter" he reveals the importance of diffusion oriented policies as a factor of economic success in certain nations. He looks at diffusion at the macro level of countries and at the meso level of institutions involved in diffusion. One of his basic propositions is that the effects of technology policies depend overwhelmingly on the national environment in which they operate and the degree in which it stimulates diffusion:

"Particularly important is whether this environment promotes the broad *diffusions* of new ideas and the rapid *adoptions* of new technologies. If it does, policies aimed at encouraging innovation can yield spin-offs across a broad range of economic activities. Conversely, in a environment characterized by low mobility of human and technological resources, the results of government-sponsored innovation will remain trapped in their originating sector or firm. The key problem for technology policies, therefore, is not that of generating new ideas, but rather of facilitating their widespread use - and this is equally valid for emerging and mature industries." (Ergas, 1986:4)

As a consequence technology policies cannot be assessed independently from their broader economic and institutional context. Ergas finds certain elements of the socio-economic environment such as the size of the scientific and technological system, its accessibility and mobility, the existence of cooperative R&D, vocational education, competition in factor and product markets and finally the size and quality of the market, crucial for the effectiveness of innovation policies. He thus supports Brown's market and infrastructure perspective, emphasising the importance of the supply side of diffusion agents.

Ergas develops a typology of countries, combining two criteria: the type of technology policy they pursue and the accent on a particular phase in the innovation process of its industries.

The first classification consists of the main approaches of technology policies of national governments: mission oriented countries on the one hand and diffusion oriented countries on the other.

Mission oriented countries will tend to focus on fundamental research and thus on the first phase of the technological life cycle. Technology policy is usually linked with objectives of national sovereignty and strategic leadership. Examples of countries that have predominantly mission oriented policies are the US, France and the UK. Defence related projects account for a high share of government expenditure on R&D. The dominant feature of mission oriented R&D is concentration in decision making, a small range of both technologies and number of industries involved (Ergas, 1986:16). This results in a technology policy with a few very large programmes.

Although the aforementioned countries have a similar type of policy, the effectiveness of these policies varies greatly, depending on how the socio-economic environment deals with the incentives of the policies. In the UK and France, the mission oriented programmes are either highly protected for military reasons, or performed by an isolated research elite, which leaves few mechanisms to disperse the created knowledge outside the projects. In the US where mobility of skills is high, and the large scale knowledge system is relatively open, the mission oriented programmes have more chance to 'trickle-down' commercially viable knowledge.

Diffusion oriented countries on the other hand focus on improving technological skills of existing firms and industries. Policies are mainly concerned with industries in their maturity phase, laying less emphasis on developing entirely new, leading edge technologies, than on promoting the widespread dissemination of technological capabilities throughout industry.

"This has primarily involved strengthening institutional mechanisms for technology transfer, in particular the education and training system, the system of industrial standardization, and the network of cooperative research." (Ergas, 1986:5)

The primary feature of these policies is decentralisation in implementation, goal setting and distribution of funds. In these cases technology transfer is very important. The innovation process of the firms moves along technological trajectories instead of making major shifts. Examples of such an approach are the Federal Republic of Germany (FRG), Switzerland and Sweden. This type of countries tends to consolidate their traditional patterns of specialisation. A disadvantage of an economy driven by a diffusion oriented innovation process is the possible conservative effect: firms concentrate on incremental innovations along existing technological trajectories. As a result they are threatened by competition of Japanese firms, which have managed to overcome the mechanical engineering predominance of European firms, using electronic-based technologies. Ergas states that the European firms have not adjusted to shifts in the technological trajectory due to conservatism of the industry-wide decision making process. We can now see that many US consumer industries, - for instance automotive and electronics industries - have similarly lost market shares to their Japanese competitors. Ergas ascribes Japan's success to the combination of both diffusion oriented and mission oriented elements in innovation policy.

Ergas' second classification, assigns a countries' major industries to the technological trajectory: the emergence, consolidation or maturity phase (see figure 1.3). For instance the US industries can be found in the emergence phase, German industries are mainly in the maturity phase, while Japan's industries are in the consolidation phase. It is this consolidation phase which brings the best opportunities for profits (Jacobs, 1990:11-13). Williams (1989) presents a similar typology, but with different positions:

"One can imagine a spectrum of environments and capacities ranging from a set favourable to basic research to another set favourable to commercial exploitation. In terms of this crude and polarized model, Europe would be located at one end of the spectrum, Japan at the other, with the United States somewhere between." (Williams, 1989:162)

The different positions are due to other factors involved. While Ergas looks at the characteristics of the main industries, Williams describes the capabilities to translate science and technology into innovation. Although these typologies give a very crude characterisation of countries, the relevant point is that every phase in the technological trajectory needs other skills and requirements and a different type of public support. Thus there is no single formula of 'best-practice' in diffusion policy.

Ergas summarises his findings in the concepts of deepening and shifting. Shifting involves the transfer of resources from old to new uses, - e.g from mature industries to emerging ones - and deepening involves improving their productivity in existing uses (Ergas, 1986:7). He shows that mechanisms by which innovation shapes the market structure are different between countries: - who gains from technological advantage in the country, does it accumulate and how flexible does the environment respond? These differences affect the evolution of each country's industrial structure.

"The greater the mobility of technical, managerial and financial resources, the greater the contribution shifting is likely to make to overall growth. Conversely the greater the extent to which assets are firm or industry specific, the greater the importance of deepening to long term competitiveness." (Ergas, 1986:46)

The US is an example of a shifting country: an extremely large applied research system, the economy is specialised in the emergence phase of technological trajectories at the frontiers of technology, constantly generating new areas of potential economic activity. There is a large mobility of resources but a relative lack of long-term commitments of firms needed for productivity enhancing investments. France is also an example of a shifting country but in

this country the transfer of resources to new industries is conducted by government initiated policy programmes. A concentration of power by a technical elite, prevents the diffusion of the technological know-how reaching areas outside the domain of these programmes. The FRG is an example of a deepening country: skills and sources are highly industry specific, technology develops according to already existing trajectories, there is a long-term commitment which favours investments in activity-specific capabilities (Ergas,1986).

Ergas' model thus reveals a relation between technology systems and policies and the innovation capabilities of a country. Chapter 4 discusses how this affects the European countries' innovation performance. His approach is a useful point of reference for the argument in this thesis in several ways. First it offers a model to analyse the character of EC policy programmes: are they designed towards diffusion of technological skills throughout the Community or rather designed to start off a strategically defined technological mission? How are the programmes managed, in a centralised or decentralised way?, who sets the goals? is there enough feedback with the - potential - users? Furthermore the approach sheds another light on the friction between national technology policies and the EC policies. To what extent are the EC programmes complementary to what is done at the national level, to what extent are they overlapping or even competing these. The emphasis on the supply side of diffusion agents raises the question how the wide diversity in the institutional infrastructures in its member countries constrains a Community wide diffusion policy, a question explored in chapter 4.

Ergas' typology is centred around decision-making processes rather than the contents of the innovation process supported. The concept 'mission-oriented policy', although very valid to describe characteristics of some policy programmes, does not address all the issues on innovation policies that are explored in this thesis. In this study the tension between 'upstream' and 'downstream' oriented policy approaches and the shift towards an integrative

innovation model involves a wider set of issues. In addition, a convergence of policy styles has taken place in many member countries, resulting in a sophistication of government support mechanisms in the second half of the 1980s. Even a 'mission-oriented' country as France has integrated many diffusion-oriented elements in its policy.

Ergas' contribution does help to distinguish between those policies that aim at the creation of radical new technologies in the emerging phase of a trajectory and those supporting incremental innovations in the consolidation and maturity phase of a trajectory.

In the late 1980s and early 1990s contributions on diffusion policy became more regular. Chiang (1991), heavily influenced by Ergas' contribution, defines diffusion oriented policy as a policy that "... concentrates on acquisition, diffusion and assimilation of technology in industry. It attempts to increase value-added for existing products by improving quality, increasing efficiency or entering niche-markets, rather than to create brand new industries". By contrast, "[m]ission-oriented policy attempts to generate and exploit radical innovation. Its ideal is to create entirely new industries based on new technologies. It tends to compete in the early phase of a technology life cycle, and to emphasise 'heroic' efforts in 'big science and technology' or major programs" (Chiang, 1991:339-340). He observes an attempt by the US Federal government to undergo a structural transition in its industrial technology policy toward a diffusion-oriented paradigm. One of the big challenges and barriers is the modification of the US institutional framework for this purpose. One reason for this change in perspective in the US is a growing scepticism about the 'spin-off' rationale that is usually used to legitimise mission-oriented policies and programmes.

A lesson from aforementioned studies in diffusion is that an effective diffusion policy should take account of the fact that the circumstances to take up new technologies are different for each firm, industry and country. Potential users do not find themselves in identical technical and economic circumstances (David, 1986). Indiscriminate promotion of the maximum possible extent of adoption is not a desirable goal for public policies. National experiences with diffusion policies are not easily transferable between countries, because the mechanisms reflect broader features of a country's economic, social and political environment (Ergas, 1986:11). This has been explicitly stated by Cohendet et al. (1992) from their analyses of diversity in Europe:

"(...) what matters in the evolutionary theory is the complex interaction between technology and local contexts, which means that a local context is an entity playing a role in the process of creation and diffusion of technologies through specific learning mechanisms that mostly rely on the specific institutional framework of the local entity considered. Therefore, different local contexts due to different institutional frameworks will exhibit qualitatively different processes of innovation. But conversely, the same types of technology will have a different qualitative impact on different local contexts." (Cohendet, Llerma, Sorge, 1992:13)

1.4.1 Diffusion policies in the industrialised countries

Innovation policy in the OECD countries is changing in character and asking for a different role of governments. The traditional policy instruments, aimed at supporting R&D directly at the firm level through subsidies are gradually replaced by indirect schemes designed to improve the innovation or diffusion capabilities of firms in general.

The emphasis on the 'upstream' stages, - using the linear terminology - leading governments to focus on 'pre-competitive' research, encloses several hazards. Firstly supporting basic research will not necessarily lead to technologies or innovations that find their way into commercial application. As discussed previously the evolutionary theories stress the importance of the both the

economic or commercial and the technological forces. As Kline and Rosenberg (1986:301) state: successful technological innovation is a process of simultaneous coupling at the technological and economic levels. The link with future economic performance is lost if this is not in some way included early in the decision process. This is particularly the case with big prestigious research projects with a particular strategic aim. "Big national and international R&D projects financed and planned directly by the state have thus become some of the most dramatic illustrations of 'government failures' " (OECD, 1992:67). It has led to massive duplication of research efforts, especially in the case of new major technological breakthroughs, and to allocating large amounts of funding to inappropriate technology. Lake and Ford (1991) clearly illustrate this with the case of fusion research in the EC. A second point of criticism regarding an 'upstream' focus is that traditional government instruments such as grants for R&D will support firms with in-house research facilities, not however a large part of firms engaged in the near market phases of R&D. This lead to a neglect of supporting innovation in SMEs.

A third point is that the linear model reinforces a dichotomy in two types of firms: one the one hand innovative firms that 'invent' new technologies and on the other hand firms that 'passively' adopt those technologies through the purchase of equipment or licenses. However in between these two extremes there is a whole spectrum of firms, that make a large contribution to innovation by alterations or combinations of existing technologies or knowledge. Governments however tend to focus their R&D support on the first mentioned type of firms and in developing diffusion policies only address the 'passive' type of firms.

Since the mid-eighties the status of diffusion oriented policies has greatly improved. In national and international contexts doubt has risen on the strategy of confining technology policy to 'upstream' research or to narrowly defined strategic technologies. Especially the acknowledgement of the

importance of SMEs and their innovative significance for the economic fabric of most countries, have caused governments to shift their attention. However in many instances this has been translated into support measures for the much more glamorous 'New Technology Based Firms', small high-tech firms which were thought to have great growth potential and could lead to technological breakthroughs because of their flexibility. The boom of Silicon Valley with its rocketing electronics firms appealed to many policy maker's image. The emergence of Science Parks and 'Incubator' schemes in almost every industrialised country is the best known illustration of this approach. Massey et al. (1992) bring up the heritage of the linear innovation model in the set up of Science Parks for discussion. The less sophisticated SMEs in the more traditional industrial sectors receive a comparatively modest attention, even though innovation can be equally important for their economic survival. Ergas sees this category of firms as an essential target group in diffusion oriented countries.

As an indication that the general mood is changing in the late 1980s and early 1990s, we can distinguish some influential contributions drawn up by a mix of academic and policy experts.

In 1988 the OECD, at the request of a number of OECD Member governments, launched an integrative and comprehensive programme to analyse a range of different technology related questions. This programme, named the Technology/Economy Programme (TEP) can be regarded as an authoritative contribution to the debate on innovation policy. A group of experts was formed in 1990, to draw the policy relevant conclusions from the material (background reports, conferences etcetera) that was produced by the programme. One of the conclusions and recommendations was that there should be more emphasis on diffusion policies, since there is already a 'supply bias' in many science and technology policies (OECD, 1991 and 1992). With supply side bias the authors refer to the support and funds going to the

knowledge creating R&D system, stemming from a 'technology push' concept of innovation.

"Diffusion policy corresponds in other words to the need for a re-emphasis on some of the demand features of the technology/economics interaction. Furthermore, technology diffusion policies, in contrast to traditional science and technology policies, while national in focus, have a far less *nationalistic* component." (OECD, 1991:70)

The controversial and troublesome aspect of diffusion policy is also recognised:

"In more recent times (...) there has been a shift towards support for *generic* technologies and for so-called pre-competitive R&D support. (...) However "concerns of policy-makers not to interfere with the market process should not lead them to identify "pre-competitive", basic research with non-applicable research. (...) in many cases of so-called generic technologies the need for support is often far more essential at the application end." (OECD, 1992:67 and 68)

The TEP report (1991) was also one of the first to explicitly stress the importance of a broad approach to diffusion:

"Traditionally, technology policy has viewed the notion of diffusion rather narrowly. Policies devised in support of diffusion have focused largely on information provision and dissemination, or on subsidies to encourage early utilisation of certain technologies. We consider that diffusion is a much wider concept and is influenced by such factors as the nature and availability of skills, infrastructure, investment flows, organisational and institutional arrangements, and broader societal attitudes. This broader approach means that in focusing on firms, it is important to consider the total environment of the firm." (OECD, 1991:25)

I have referred to this as the 'absorptive capacity' approach to diffusion, which also alters the policy scope of innovation policy. More than ever before, it is not only an area for Ministries for Science and Technology or Industry, it requires the co-ordination with a whole range of policy areas affecting diffusion.

The translation of diffusion policies into policies for 'generic' and 'pre-competitive' technologies can be also recognised in 1980s' policy initiatives of the Federal government in the U.S. (Chiang, 1991:347). The Bush administration announced in its first technology policy statement *U.S. Technology Policy* a growing effort in diffusion oriented measures including government participation in pre-competitive research on generic technologies that have the potential to contribute to a broad range of government and commercial applications (Chiang, 1991:345). The Clinton government shows an even larger commitment to diffusion policies. It has proposed to develop a national network of manufacturing extension centres to help SMEs gain access to technology, to invest in applied R&D and increase partnerships between businesses and national laboratories. Education and training are important elements of a 'Technology for America's Economic Growth' policy (Clinton/Gore, 1993).

In European countries we can also see a trend towards government policies that are more decentralised and aimed at improving the innovation capabilities rather than directly supporting research and development, either at research organisations or firms. For instance a trend in France is to set up regional networks between firms and the research establishment to spread the scientific and technological knowledge present at the many public research centres (Fahrenkrog/Boekholt, 1993).

To illustrate that the issue is achieving greater weight, also on the side of the European Commission, the SPRINT programme of the European Community brought together a group of influential experts, both from an academic and policy background, to discuss the consequences of the integrated approach for Community policy. This led to the publication of the so called 'Maastricht Memorandum' (Soete/Arundel, 1993). This does not reflect the Commission's philosophy of innovation policy, but it is a sign that the debate on the appropriate approach to innovation has reached the EC policy level. Drawing heavily on the state-of-the-art theories of the evolutionary economists, partly

discussed before, the authors embrace the integrative approach to innovation and technology diffusion policy. It also shows the interactive process of influence between the academic and policy making communities. In chapter 3 the Commission's change of approach to innovation is discussed on the basis of the so called Framework Programmes.

The change in policy emphasis is not only the result of this interactive process. It is forced by economic logic, through changes in the international markets. Many firms have experienced several forces that made them rethink their innovative strategy, including more diffusion type activities:

- the rising costs of R&D and the shortened life cycles of new products have lowered the returns on R&D investments. This has resulted in more pressure to benefit from existing knowledge and technologies and collaborate with other firms or knowledge centres. Networking to obtain this external knowledge in contrast to in-house research has gained importance.
- With the increased global competition and the emergence of Japan as the world leader in many high-technology products, the insufficiency of investing in research as a means to catch up became manifest. It was widely accepted that Japan's lead position originated from capabilities in application of state of the art knowledge in value adding consumer products, and in their integrated organisation of the production process. In many areas of consumer products and electronics Japanese competitors have achieved market leadership through better product engineering and design and market concepts.
- While public innovation support tended to concentrate on the science-led high-tech firms, firms in many low and medium-tech sectors in the 1970s and 1980s were forced to innovate due to global restructuring processes. This called for a broader set of support mechanisms than R&D funding.

Thus appeals to change the basic design of public policy for innovation, reached policy makers from different angles. Part of this appeal came from the community of analysts of the innovation process, who have become more closely intertwined with the networks of policy makers.

1.4.2 A taxonomy of diffusion policy

Diffusion policy is an ill-defined concept, used to describe a wide range of government actions. David (1986:374) states that in the most wide sense all policies that influence the investment decision to adopt a new technology are considered to be diffusion policies. This includes for instance monetary and fiscal policies (tax treatment of investment), macro-economic policies, energy policies, educational policies, patent laws and anti trust policies. Indeed creating an economic environment "conducive to the rapid adoption of new techniques" is a necessary government task, that should accompany more specific diffusion action (OECD,1992:62). However this very broad definition prevents us from obtaining a more detailed understanding of how governments can stimulate the spread and adoption of best practice technology throughout the economy. In addition, David's definition seems to look at diffusion only from the angle of firms that are 'passive' recipients of new technologies created by other innovation led firms.

A better understanding is achieved if we broadly divide between public innovation policies aimed at generating leading-edge technologies and those at improving the utilization of technology. In terms of the target groups it is the 'picking-the-winners' approach versus an approach to improve the absorptive capacity of - a particular - industry. Some authors (Ergas, 1986, Sharp 1989, Roobeek, 1991) have shown that in many countries, a technology policy inspired by the linear model, tends to favour a 'mission-oriented' and/or 'picking-the-winners' approach. This is because support programmes

are often aimed towards radical innovation in high-tech sectors in narrowly defined technological areas. The OECD/TEP report (1992) distinguishes between policies motivated by problems or obstacles related to spillovers or to absorption. One of the major policy issues these experts want to point out is reconciling the conflict of public and private interest concerning the spillover effect. On the one hand the interest of the innovators is to guarantee as much of the gains from the innovation as possible, thereby attempting to restrict the amount of information that becomes publicly available- and at the same time maximising the innovation's use. On the other hand it is in the public interest to maximise the social returns of innovations through low cost diffusion of technology. If the expectation of private returns is not high enough, - the innovation can be immediately imitated -, there is no incentive to make the innovative effort. This can be a problem in publicly funded collaborative research projects, where firms are pressed to share their results with competitors and disseminate them publicly.

Reviewing the aforementioned literature, we can identify many support mechanisms that have essential diffusion features. They address both diffusion as part of the technology creating process within a firm and its surrounding networks and as acquisition of knowledge through equipment or components. The following lists give a taxonomy of essential elements of diffusion policy³.

In a traditional model of innovation diffusion includes:

- supporting the access to knowledge by setting up technology transfer agents and spread of information on innovations (databases, bulletins etcetera);
- encouraging the adoption of specific technologies;

³ In this thesis the focus is on government action directly aimed at diffusion, rather than indirectly creating the right environment.

- financial assistance for the purchase of process technologies (tax incentives, subsidies);
- increasing the chances of dissemination of technologies by encouraging technical standardisation;
- ensuring expectations of significant private returns by means of intellectual property policy.

The integrated innovation approach would put different emphasises and include additional elements in the innovation support policy:

- concern for the non-technological elements that increase the absorptive capacity of firms such as investment in human capital and skills (training), management support (supporting network management). In this study we will concentrate on the diffusion processes at the firm level, excluding policy for vocational training and education.
- Demonstration projects that show the entire implementation process.
- R&D support that does not only cover the scientific research aspects of innovation projects, but takes the design and marketing phases into account. Research projects supported would be more 'near market' and ideally embedded in an overall innovation strategy of the firm. Since, in most countries, governments would not engage in these functions at the firm level, more general indirect schemes could be expected. Examples are Design Awards, support for collective research organisations (applied industrial research) for SMEs, encouragement of collective Marketing Boards and so on.
- Setting up and/or enhancing an innovation support infrastructure that comprehensively covers the innovative firms' needs: not only the research aspects on the one hand or the acquisition of licenses and patents on the other hand. An example would be a scheme that supports the use of an external consultant to integrate the implementation of new technologies into the strategic business plan of an SME.

- Stimulating the creation of formal and informal networks by means of collaborative partnerships, collective industrial associations for research and design, industry-research links, to enhance the firm's learning capability.

An essential element of diffusion policy is that it supports a wide set of industries sectors and technologies instead of a limited target of technologies and their producers. This is related to, what Ergas (1986) considers as a key element of diffusion policy: the decentralisation in implementation, goal-setting and distribution of funds in policy programmes. Technologies that have a wider impact on several different industrial sectors and allow different applications are the so called 'generic technologies'.

This wider scope of government intervention irrevocably raises the issue of its limits in terms of interference with market forces. An often used criterion for government intervention, in public policy literature as well as by policy makers themselves, is that it should only act in case of 'market failure'. The reality of public policy is however much more complex and dependent on political choice and interpretation. In the framework of this thesis a discussion on this issue would lead too far afield. We will assume that this criterion can be used to assess what governments should and should not do. But blurring of the borderlines between science, technology and product development, complicates this assessment. "The appropriate limits to government intervention are ill-defined and all the more easily transgressed now that the traditional linear model of innovation seems increasingly obsolete" (OECD,1991:23).

1.5 Conclusions

Literature suggests there is an appreciation of the diffusion oriented aspects of innovation policy in many OECD countries.

The change in thinking in innovation literature has influenced the awareness of policy makers of the necessity to support the spread of applications of existing knowledge and technologies throughout the economic fabric. At the national level policy makers responsible for innovation policy in the OECD countries have increased instruments to support technology diffusion, although with large differences in their weight and implementation methods. The question to be discussed in the subsequent chapters of this thesis: how have policy makers responsible for European Community innovation policies incorporated diffusion in their programmes and mechanisms to support innovation in industry?

The literature review on diffusion and diffusion policy allows us to draw two sets of conclusions. The first set of conclusions relates to the shift of the dominant innovation model and its consequences for diffusion. The shift in the thinking on the innovation process, for a long time dominated by the linear model, is moving towards the 'integrative model' of innovation. This shift in perception has consequences for the thinking on the role of diffusion. In the linear model diffusion was mainly the last phase in the pipeline: after research and development had led to new technologies, the diffusion process involved the spread to potential users. The two are seen as separate processes in a fixed sequential order. In the integrated model, as we have seen highlighted in the OECD report (TEP) and the Maastricht Memorandum, diffusion processes are interlinked with the dynamic capacity of firms and institutions to develop and apply new knowledge through a cumulative process of learning. Diffusion in this model is a much more complex mission which involves not only the spread of technology throughout the industrial fabric, but also the absorptive capacity of firms to use and adapt existing technologies. Diffusion is closely related to business functions traditionally related to innovation. Both

the creation of new knowledge and innovations and their diffusion have the best chances for success if embedded in an innovation strategy which includes the market perspectives of these innovations. Furthermore, the diffusion process is different for different technologies and industries.

The second set of conclusions relate to the consequences for public policy. Diffusion policy from the linear perspective tends to neglect the institutional context of innovations and the importance of the absorptive capacity of firms to benefit from these support efforts. Contributions by Ergas and others have shown that the institutional and socio-economic context are essential for diffusion policies to be successful. We have also seen that innovation policy in most European countries is moving away from the exclusively linear approach where support is focused on the research performance of public bodies and firms, towards a more integrated approach aimed to improve the absorptive capacity of firms and institutions.

Figure 1.4 combines some of the elements of the above mentioned discussions and perspectives to illustrate the consequences of a different approach to innovation and diffusion for the focus of public support.

In the traditional linear model the main diffusion concern is the improvement of the exploitation of research results from public research efforts. The principal mechanism to overcome diffusion barriers is thus to improve information and communication infrastructures to disseminate these results to potential adopters. The main concern of the integrative approach involves the improvement of the absorptive capacity of firms to implement and/or apply available technologies and knowledge in such a way that it fits their innovation strategy. This requires a much more complex set of support mechanisms, fine tuned to the different contexts of firms, industries and geographical location.

Figure 1.4: *Dominant diffusion policy support mechanisms in a linear and integrative innovation model*

	<i>linear model</i>	<i>integrative model</i>
adoption perspective	databases/ information bulletins on technological research dissemination of research results encouraging technical standardisation	demonstration projects quality of design
infrastructure perspective	technology transfer agents	innovation support infrastructure
comprehensive absorptive capacity approach	information campaigns, one-off collaborative projects	improving networking capacity, support for managerial capacities

We have discussed the literature on diffusion and its support policy at a national level. Both the influence of the community of innovation experts and developments in European industry urged policy makers to change the perspective of public innovation policy. The following chapters of this thesis aim to investigate how this debate has influenced RTD policy making at European Community level.

2. CONSTRAINING AND FACILITATING FACTORS IN THE EC POLICY CONTEXT

2.1 Introduction

The ongoing process of European integration is to a large extent a strategy to meet the economic challenge of the United States and Japan. Improving competitiveness by means of enhancing European innovative capacity is only one of the elements of this strategy, but an increasingly important one. Research and Technological Development (RTD) policy at European Community level has achieved greater weight in recent years. It is one of the policy areas in which the Commission has created its own direct instruments with financial funding for firms, research organisations, universities and innovation support services. New European research centres were set up, research and technology organisations were associated and people from various types of organisations joined to perform collaborative research. EC funding for R&D programmes has more than tripled between 1984 and 1993.

In the previous chapter we discussed the shift in innovation policy in the industrial nations from a science-push linear model towards a more comprehensive and integrated approach. Support for innovation entirely focused on the upstream, science led phases of the innovation process, has been complemented by a wider set of support mechanisms, such as incentives for SME networking, setting up technology transfer infrastructures and so on. In addition, large scale mission oriented actions and the 'picking-the-winner' mentality have lost momentum in recent years. This has paved the way for policy initiatives to facilitate the spread of innovation, throughout the industrial fabric.

The main problem in this study is to investigate if this shift in favour of diffusion oriented policies also occurred in European Community RTD policy.

The just described evolution of national policies has been a long-term process. Before we look into the actions and programmes that have been set up by the EC, this chapter will investigate the facilitating and constraining factors in the EC political context, for trans-national diffusion oriented policy. European Community policy making has different perspectives, in terms of decision making, consensus building, sources of influence, compared to national policy making. We will explore how this effects the shift to an integrated model of innovation and particularly the position of support for diffusion.

Theoretical concepts of and empirical research on government regulation in innovation concentrate at the national policy level. RTD policies were and still are a mechanism in competition between countries, to gain a competitive position for their indigenous industries. Community RTD policy suggests a different approach, because of its supra- and transnational character. Countries that thus far had been each others competitors or at least separate entities in policy design, are now brought together at the European policy making level. In how far do the national concepts apply for this level of policy, and what are the additional dimensions of these transnational policies?

The argument in this chapter is that the European level adds to the complexity of policy making and the layers of conflict involved. To understand the EC policy making process, we have to elucidate the policy context that defines the boundaries for diffusion policy and influence the priority choices in RTD policy. We will look for constraining and facilitating forces for a shift towards the integrative approach.

2.2 RTD policy and EC integration

The character and perspectives of RTD policy are not untouched by the major changes in the European integration and its development from the original EEC Treaty, the Single European Act to the Maastricht Treaty. The shift from

'Eurosclerosis' in the early 1980s to a 'Euro-optimism' in the late 1980s formed a boost for the RTD policy area.

According to Andersen and Eliassen, the study of EC integration, has been dominated by the legal viewpoint, looking at the formal aspects of decision-making in EC institutions. From the political sciences, in particular international relations studies, EC integration is often looked at from the neo-functional approach (Williams, 1989)⁴.

"Neo-functional theories first assumed that integration would proceed exponentially as successful common policies in highly technical, non-controversial sectors would require common policies in other related sectors due to technical pressures (*functional spill-over*). Secondly, newly integrated policies would hasten the transfer of political authority to pan-European institutions largely due to political pressures from interest groups and political elites whose interest were served by European institution-building (*political spill-over*)."

 (Peterson, 1990:274)

An often chosen research subject is lobbying by interest groups in the Commission (Peterson, 1990, Andersen and Eliassen, 1993). Another field of study concentrates on the effects of the European integration on - mainly macro - economic parameters such as intra-Community trade, the size of the Single Market, the reduction of transaction costs and so on⁵.

Studies linking these general policy perspectives to Community policies and programmes in the area of Research and Technological Development are few. Most contributions concentrate on particular programmes and technological areas such as information technology and in particular ESPRIT (Freeman et al., 1991, Sharp and Shearman, 1987, Sharp 1989, Peterson, 1990, Mytelka and Delapierre, 1987, Roscam Abbing and Schakenraad, 1990, Sandholtz, 1992). The problem with this abundant focus on the ESPRIT programme, is that general conclusions on RTD policy are often made on the basis of this distinct

⁴ See for a discussion Andersen and Eliassen, (1993), Peterson, (1990).

⁵ See for instance the Cecchini report (1988), and Jacquemin/Wright (1993).

case. Indeed, ESPRIT as the first and most ambitious programme, has influenced the design of subsequent EC programmes, but has very distinctive features, compared to other EC policy initiatives.

The position of EC RTD policy has been firmly rooted in EC legislation only recently, corresponding with the political aspiration of the Commission to have more authority in this field. This political and legal shift has been prompted by developments that affect European economies: increased global competition, periods of recession, declining industries in the industrially developed countries and rising costs of R&D for the high-tech sectors. The seriousness of these problems has induced common action by the Member States, who previously conceived each other as their adversaries. Science and technology is considered as the motor for improving international competitiveness of European industries. The European Commission has been assigned to play a key role to support this process. Its role is basically a supplementary role to that of the Member States' innovation policy. The scope and weight of this role have been subject to struggles of power between the Member States.

The fear of the economic lag of Europe vis-à-vis the USA and in later years Japan are the main force not only for RTD policy, the creation of the European Community itself can be seen from this perspective.

In the fifties, the years of the establishment of the EC, it was a lower level of productivity that alarmed policy-makers. Sudden concern in Europe for a technological lag was triggered by Servan-Schreiber's influential book *Le Défi Américain* (1970)⁶ which prompted a large amount of literature. The concern then focused only on the USA as a competitor, the Japanese challenge was noticed several years later.

It was only towards the 1980s that this alarm persuaded policy makers, who subsequently focused their attention on specific technological lags. The

⁶ Dutch edition - original edition was from 1967.

technological gap with Japan and the US was considered a threat to European competitiveness, especially for strategic industries like information technology (Pelkmans, 1987). The Commission realised that creating a Single Market alone is not sufficient to establish a strong competitive position for European industries. Policy initiatives in US and Japan to support technology in their industries were watched keenly. Following ambitious national initiatives in these countries such as the Japanese Fifth Generation Programme, the Commission concluded that it was time to launch large scale innovation programmes itself (Arnold/Guy, 1986, Sharp, 1989). A more detailed account of the implementation of policy programmes is given in the next chapter.

Motives to directly stimulate research, development and innovation have been articulated by the Commission as follows:

- in some technological areas, cooperation in science and research can create *scale effects* which will give it the 'critical mass' it needs confronted with the huge US and Japanese R&D efforts;
- joint R&D can have *financial benefits*, especially considering the rising costs of R&D;
- given the differences in specialisations in R&D and competitive industries in the EC countries, cooperation can take advantage of the *complementarity* of knowledge and experience;
- it will facilitate the European *integration*, and at least create a better standardisation of scientific and technological knowledge (CEC, 1985b:9-10, CEC, 1988a).

At present the overall objective of research and technology development policy is stated in Article 130f of the Maastricht Treaty :

"The Community's aim shall be to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level."

It reveals a predominantly industrial commitment of research and technology support, a tendency that became more predominant during the 1980s. The seriousness of the economic problems and the perceived weaknesses of European industry created ample consensus between the Member States that common action at the European level was needed. Thus the common threat was the basic motive behind joint action for RTD support, there is however conflict over the ways to achieve the goals. In addition, although the common goal is to improve the competitiveness of European industry, that does not imply a consensus on the definition of exactly which industry to support.

RTD policy is an area where EC authority, - in relation to the Member States - has grown fast in the last decade. It has been more and more embedded in a wider range of EC policies aimed at improving competitiveness of European industry. The development of this policy area has been and still is a battlefield of political conflict.

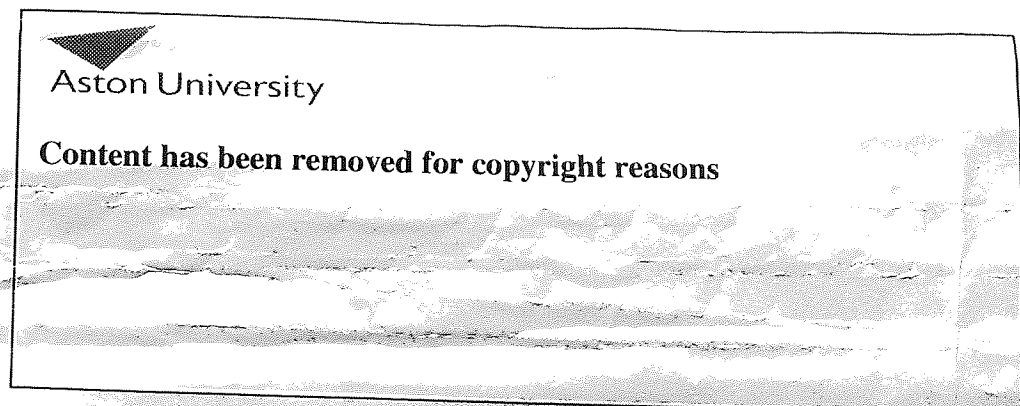
In an article on technology policy in Europe, Peterson (1990) systemises the political conflicts in this policy area. He is highly critical of the neo-functional approach described above, since the study of technology policy shows that the functional and political spill-over effects are not as clearcut as neo-functionalists would like to believe:

"In reality, the rise of pan-European R&D schemes has been characterised by widely divergent goals and substantial political controversy between EC Member States, and only limited integration of national policies. Technology policy as a case study reveals that designing or redesigning one theory to explain the EC's multi-faceted and diverse pattern of development, even in a relatively narrow area of policy, is a highly daunting exercise." (Peterson, 1990:275)

Peterson's article focuses on the state-industry relations and the position of pressure groups. He ascribes the emergence of EC RTD programmes in the mid-1980s to the rise of a 'collaborative community', "(...) after Europe's largest and most powerful European technology producers and consumers had

coalesced into broadly unified, truly pan-European industrial pressure groups (ibid.:270). He argues that the RTD programmes have provided industry with a significant and unprecedented role in decision-making on goals, organisation and funding priorities. This has certainly been a factor at the launch of programmes like ESPRIT, and EUREKA, Peterson's two cases. But the role of industrial pressure groups became much smaller in the following years of these programmes. Peterson acknowledges that changes in the political agendas in later years, have diminished these direct relationships. A key notion in Peterson's article are different types of 'networks' that effect EC decision-making. He observes 'policy communities' and 'issue networks' or pressure groups. Peterson distinguishes between three levels of analysis (figure 2.1)

Figure 2.1: European technology policy - levels of analyses



Source: Peterson, 1990.

In this thesis, following these levels of analyses, we will discuss how the progress and scope of RTD policy meet conflicts at several political layers:

- there is political conflict between the Member States on one hand and the European Communities on the other, concerning the political level responsible for the design and implementation of policies. This involves

deciding what authorities are transferred from the national to the Community level.

- There is political conflict amongst the Member States to influence the contents of Community policies and the appropriation of budgets.
- At the level of the policy programmes there is a conflict between industrial communities to influence the allocation of Commission resources.

This study of EC diffusion policy, shows that to understand RTD policy an additional level of conflict should be studied, one which Peterson neglects:

- within the Commission there is a conflict between competing policy domains.

Not all policy domains and corresponding Directorates have an equally strong position in the agenda setting of the Commission and its budget allocations. Thus there are 'policy communities' within the Commission with different interests and on whom the influence of the outside 'innovation experts community', as introduced in the first chapter, is disparate.

This chapter of the thesis will discuss how these conflicts in the different layers effect EC RTD policies and in particular the position of diffusion oriented policies. Not all levels of conflict will be treated in the same detail. From the viewpoint of understanding the shift in the approach of innovation and diffusion, the conflicts between Member States and the internal Commission conflicts are considered to be the most essential forces. However intensified industry-Commission alliances probably have a positive effect of diffusion orientation of programmes since industry can be expected to be more concerned with the commercial possibilities of research projects. While systematic alliances are manifest in the case of ESPRIT and the 'Big Twelve', for other programmes these alliances are much more obscure, if not absent. The lack of research in this field, obliges this factor of influence to be left outside the scope of this study. The boundaries between the layers are not clearcut and the conflicts in each layer are influenced by those in the other

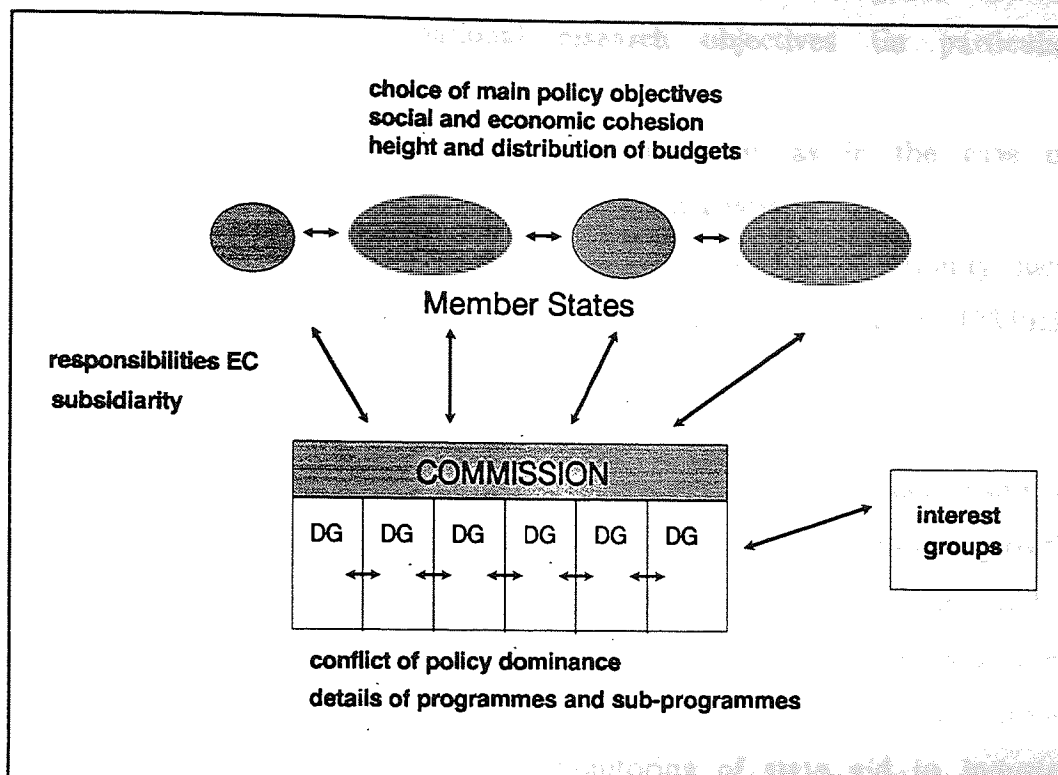
layer. However, each has a different impact on the outcome of RTD policies. For example the internal Commission conflict between 'interventionists' and 'liberals' is a reflection of the differences in styles of regulation between Member States. Peterson introduces several policy networks that influence EC technology policy. The present study adds two more sets of these policy networks: on the one hand the 'community of innovation experts' analysts outside the EC, who do not only contribute through literature, but also through their presence as advisors to the policy makers. On the other hand we can distinguish various - sometimes rivalry - 'policy networks' within the Commission. In the case studies, in chapter 5 and 6, we will see how this effects policy making at the programme level.

Figure 2.2 gives a schematic picture of the political pressures that surround the decision making and implementation of RTD policies.

2.3 Member States versus European Communities: the legitimization of EC responsibility in RTD policy

The first layer of conflict is that of the Member States versus the EC. It is basically the discussion of the responsibilities, tasks and authority given to the EC by the Member States. In case of RTD policy it defines the Commission's room for manoeuvre for the policy implementation. This has been a historical process, of which the legal boundaries are set by the subsequent treaties and acts that have revised the original Treaty of Rome. The most important ones have been the Single European Act ratified in 1987 and the Maastricht Treaty which has been in operation since 1994.

Figure 2.2: Four layers of conflict in EC decision making



Community efforts to strengthen the RTD base of European industry originate from the start of the Communities, but it has only been legitimized in the Single European Act. "Thus, the Single Act has legitimized, as it were, the Community dimension of technological co-operation by linking it closely with the other objectives geared to the attainment of a genuine European economic area, ..." (CEC, 1986g:1). This does not mean that the nation states have given priority to Community decision making in comparison to their national policies.

When the Commission was preparing the proposal for the first Framework Programme in 1983, the Council asked the Commission to specify the grounds and the selection criteria for Community action. In a revised proposal the Commission gave five criteria for Community action:

- the scale of the research activity: when the efforts are too high to perform on the national scale;

- the size of the potential market: when the research objectives require a large and integrated market (as with information technologies);
- in the case of transnational research objectives (in particular environmental research);
- in the case of a collective research problem, as in the case of thermonuclear fusion and safety in power installations;
- in the case of support for the overall objectives of the Community, such as development policy: the so called 'horizontal' activities (CEC, 1983b:3-6).

In the eighties, national RTD policies became a core part of mechanisms to support a nation's vital industries. Attracting and supporting firms with growth potential, producing strategic technologies or because of their significance for employment, became an instrument in the competition with other countries. The OECD even warned of a 'subsidy war' among the world's richest nations, which asks for better international monitoring of state aid to industry (Financial Times, 2-2-1990). Roobeek (1988) has described this as a 'race without finish' since the competing countries are exactly copying each others strategic policy options, out of fear to miss out on an important technological development. Her examples are micro-electronics, bio-technology and materials research. Each country has its own style and objectives regulating this support. The question is how much of its sovereignty the countries are prepared to relinquish. It is mainly in the Council of Ministers that decisions are taken on which territories the Community can regulate and implement policies. Up to now European RTD policy is financially still only a small fraction of the expenditures on R&D at the national level. The share of EC financing of public R&D budgets of the 'European 12', fluctuated around 2 % between 1980 and 1984, to increase to 3,5 % in 1989 and 4,5 % in 1991 (CEC, 1992b:10).

For each country the policy outlook to EC funds will be different, depending whether EC support measures are additional to or a displacement of national efforts. In Great Britain there was fear among research institutions that increased EC funds caused a direct decrease of national budgets. In 1992, the British Ministry of Finance announced large reductions in the national R&D budgets in connection to increases in the EC R&D budget (Skoie, 1993). There was even speculation that success in international tenders would reduce chances of selection for national research funds (Stein, 1993). In recent White Papers on RTD policy in the Netherlands, it is explicitly stated that EC funding is additional to national funding, a position all Member States should take in order to keep up in the technology race with Japan and the US, according to the report (Minister of Economic Affairs, 1993). However the OECD science and technology indicators for 1987 - 1992 show an increase in the total government budget appropriations or outlays for R&D in all Member States except for the Netherlands and Denmark (and a slight decrease in Spain between 1991 and 1992) (OECD, 1993). With the economic recession hitting most Member States in the 1990s, the strain on the public budgets could tempt national governments to transfer R&D efforts to the European level. On the other hand this strain has a positive effect on more decentralised diffusion type of policies, since governments will look for support mechanisms with low budget implications. Delors' 1993 White Paper 'Growth, competitiveness and employment' gives an indication of this attitude towards RTD spending: "As it is difficult to increase public spending, the Member States agree on the need to promote investment in RTD in the private sector especially and to increase the effectiveness of their RTD through cooperation between companies and with universities and research centres" (CEC, 1993a:86). So apart from the possible merits of networking, governments seem to see it as an inexpensive way to enhance innovation.

With the ongoing European integration, triggered by the White Paper on Completion of the Internal Market of 1985, the Single European Act of 1987,

and subsequently the Maastricht Treaty of 1993, the discussion on the boundaries of authority has revived. The federalist approach to the European Community reached increased momentum, which at the same time caused alarm in some countries, fearing that too much sovereignty would be lost to the Community. The debate has converged around the concept of subsidiarity. Despite the vagueness of the concept it has started to appear more often in key EC documents in the second half of the 1980s. Delors states that subsidiarity can be used in two situations: "... on the one hand, the dividing line between the private sphere and that of the State, in the broad meaning of the term; on the other hand, the repartition of tasks between the different levels of political power" (Delors, 1991:7). I will confine the discussion to the second use of the term because the policy making at the different levels is the focus of the thesis and because most of the public debate is on this aspect of subsidiarity.

In the Single European Act the principle of subsidiarity was first explicitly mentioned, but only in relation with environmental policy. It states that:

"The Community shall take action relating to the environment to the extent to which the objectives... can be attained better at Community level than at the level of the individual Member State." (SEA, art. 130r)

The public and political debates preceding the Maastricht Treaty have intensified the importance of the principle and extended its scope over all Community areas. Article 3b, paragraph 2 of the Maastricht Treaty states:

"In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can, therefore, by reason of the scale or effects of the proposed action be better achieved by the Community."

The rise of the principle's eminence also has its influence on decision making and implementation of RTD policy. The result is that policy makers at all

levels have become more aware that some type of RTD instruments are best developed and/or implemented at national or even regional level.

The Commission's opinions on how to apply this principle in RTD policy is expressed in the document 'Research after Maastricht. An assessment. A Strategy'. Subsidiarity serves as a guideline for the selectivity of Community actions, given the limited resources, although the principle gives ample scope for interpretation (CEC, 1992a). Key words are 'scale' and 'effects'. The Commission's interpretation is that these should be approached separately, they do not necessarily need to be present together (ibid.). The Commission gives five examples of cases in which the criteria of scale or effects are plainly present:

- 'big science' activities, often in the form of 'mega-projects';
- priority technology activities of which "(t)he most commonly known examples are found in industries relating to electronic components, advanced software, new industrial technologies with an environmental component, advanced technologies with an impact on transport or molecular biology";
- RTD activities destined to structure the Single Market, which implies mainly large scale networks to unify specific activities such as air traffic control;
- activities of pre-normative research, of which "health, security and protection of the environment are natural sectors for Community regulation";
- activities to foster a European scientific Community through human resources mobility programmes.

Although these examples are said not to be an exhaustive list of activities, it does structure the legitimacy of (future) Community actions. "Not all the core themes currently present in the Third Framework Programme do appear to satisfy equally the criterion of subsidiarity" (ibid.)

The legitimacy of diffusion oriented policy programmes at the Community level, has become more difficult if the subsidiarity principle is interpreted and implemented in the way this document describes it. The mission-oriented 'big-science' R&D projects are more easily justifiable because of their obvious scale. In industry related R&D there is a shift from industry related approach to a targeted technology approach. The background is the Commission's conclusion on the main negative aspect of EC RTD policy in the early 1990s: the "dispersion of resources" and "insufficient account taken of technological priorities". "(...) actions dealing with technologies of limited importance can be useful in terms of disseminated importance. They are however not enough to take up the challenge represented by the main technological priorities" (CEC, 1992a:20). This reads as a direct attack on diffusion oriented policy at EC level. The targeted technologies are defined according to a specific application area: electronic components, environmental, transport. Electronic components is a technology area with a wide application potential. A judgement of its diffusion 'friendliness' can only be made after appraisal of the interpretation of targeted technologies in the specific programmes.

The programmes for mobility of human resources, mainly by means of grants for researchers to work temporally in another Member State, can be seen as support for the diffusion of tacit knowledge. The practical outcome of this scheme is the 'europeanisation' of the academic science community, which is not necessarily related to a 'europeanisation' of technological innovations.

The Maastricht Treaty has also increased the control of the European Parliament and its influence in the decision-making process. Member States through their elected MEPs, have a more direct channel to state their priority choices in for instance the Framework Programmes. The Commission is aware of the fact that they need to consider more than before the interests of the different Member States. A 'spirit of cooperation between the institutions' is said to be the only way to avoid serious difficulties in the more complex legislative procedure after the Treaty (CEC, 1992a:34-35).

A line of action triggered by the subsidiarity discussion is an increased Commission effort to support the creation of many regionally based and internationally linked networks for the dissemination of information on the RTD policies and project results (Euro-infocentres, Value relay centres), for technology transfer, (SPRINT networks) for the enhancement of innovation of SMEs in less advanced regions (Business Innovation Centres), for the provision of risk-finance to innovative SMEs (European Seed Capital Fund Network) and so on. Because of a lack of co-ordination within the Commission, an obscure landscape of partly overlapping 'Euro-networks' has emerged. National and regional innovation support centres are often the official representative of more than one of these Euro-networks, making European policy even more complicated for those who seek information or support. However the approach of widening the linkages opportunities for firms around the Community is certainly a positive force for diffusion.

2.4 Competition between Member States over EC RTD policy

The second layer of conflict is reflected by the discussion between the Member States over the height and distribution of budgets for RTD policies and the breakdown of the appropriations for specific areas. Each country wishes to benefit as much as possible from the EC RTD programmes and thus seeks to influence their direction. Its control over these issues is channelled through the Council of Ministers, who decide over the broad priority areas and distribution of funds between the various programmes. This political debate is at its height during the Council meetings on the Framework Programmes, setting the aims and priorities and budget outlines for RTD policy over a period of four to five years. The outcome of these debates provide the structure for the long term overall objectives.

We can see on the one hand the attitude of 'juste retour': countries want the Community to invest in areas where its industries can benefit from the support programmes. (Cadmos 1991, Ergas, 1992) An illustrating example is the fierce objections from the UK to EC support for high definition television (HDTV) (Financial Times 17-11-92). Since none of the British 'national champions' are involved in the manufacturing of the relevant hardware, it has been very difficult to convince Britain to spend large budgets on this technology. In contrary to intergovernmental programmes like Airbus, the Community programmes do not formally apply the 'juste retour' principle. Collaborative research projects are selected by public call for tenders. However it is commonly known that the selection committees are directed to keep a Community wide participation in mind when selecting research consortiums. Because this is arranged informally and with a certain degree of secrecy, the effects of these directives are obscure. Even statistics on the distribution of funds over the Member States are only disclosed at such aggregate levels, that programme specific conclusions can hardly be drawn.

On the other hand we can see an attitude that Henry Ergas (1992) describes as "internationalising the mission-oriented effort", a development he observes in Britain, France and Germany. This implies a shift of the risk for large scale failures from the national to the European level. "... the desire to continue to pursue these policies make it increasingly likely that they will be replicated at a European level" (Ergas, 1992:10). However most of Ergas' evidence is drawn from either non-EC collaboration projects as Airbus, and Concorde or past EC collaborations that have long changed character as in the case of Euratom. He is however right to emphasise the danger of the subsidiarity discussion pressing policy programmes towards the large scale 'big science' projects as described above (Ergas, 1992:13).

There are basically two conflicting approaches to EC's role in RTD policy: an externally oriented RTD policy and an internally oriented RTD policy. These

conflicting approaches can be ascribed to conflicting objectives of Community RTD policy: "European technology policy has been given the mandate to make compatible the objectives of increasing internal cohesion and improving the international competitiveness of our industry" (Caballero Sanz and Catinat, 1992:194)⁷.

According to the first approach, RTD policy should be directly concerned with the Community's competitive position towards its main rivals the USA and Japan. The loss of competitive position in relation to these countries is mainly determined by Europe's technological lag in 'high-technology' industries. EC's RTD policy should therefore support these 'leading edge' technologies and the industries that produce them.

"Given the diffusive and enabling nature of these technologies, the future of European industry will heavily rely on Europe's industrial and technological performance in these sectors, which are at the core of the rest of the productive sectors of the economy" (Caballero Sanz/Catinat, 1992:194). One political problem of this approach is that the geographical distribution of these industries is a result of a long process of market forces and national industrial policies.

"(...) it is a fact that most of these high-tech activities are located in the technologically more advanced countries. As a natural result of this pattern in the geographical deployment of high-tech activities, those countries and regions are the main beneficiaries of European RTD programmes designed to maintain Europe's position in the world's technological frontier." (Caballero Sanz/Catinat, 1992:195)

The second approach sees the strength of Europe's competitive position deriving from a strong Internal Market where the differences in technological capabilities between the Member States are being reduced. In this approach

⁷ Note that authors are respectively economist for DG XIII and Head of Division at the Directorate-General XIII in the Commission, although speaking in a personal capacity.

RTD policy is not only an instrument to improve competitiveness, but also to achieve economic cohesion of the Community (Starbatty/Vetterlein, 1989). It is not surprising that the first approach is supported by the large and advanced countries in the Community and those countries that have large 'high-technology' firms engaged in the 'technology race' with the Japanese and United States giants. According to this line of thought, the Community should focus on strategic technologies, in particular micro-electronics and telecommunication technology, since these will eventually be decisive for the competitive position of all industries in Europe. The efforts of national firms and governments in these strategic areas are not sufficient to overcome the technological lag with the main competitors. The second approach is strongly advocated by the less favoured countries in Europe and has gained political weight with the entrance of Spain and Portugal in the EC in 1986.

This conflict of approach is reflected in the internal Commission conflicts over dominance of policy domains. The debate on the balance between the two approaches was triggered by the adoption of the principle of social and economic cohesion (Shoults, 1991). It was the Single European Act which played a key role in orienting all Community policies towards the improvement of economic and social cohesion. It reflected Community pressure for a more integrated, competitive and cohesive Community in Article 130a of the Act:

"In order to promote its overall harmonious development, the Community shall develop and pursue its actions leading to the strengthening of its economic and social cohesion."

"In particular the Community shall aim at reducing disparities between the various regions and the backwardness of the less-favoured regions."

Cohesion is a long term objective and applies to all Community policies as a guiding principle. RTD policy has come under greater pressure, to contribute to the principle. It lays more emphasises on the importance of the

geographical dimension of RTD programmes, which has not had great priority until the late 1980s.

"While the Parliament and the [Economic and Social] Committee perceive the RTD role as capable of making significant contribution to cohesion, the Commission proposals and the adopted RTD policy reveal, in general terms, a perception that the RTD policy role is to be limited." (Shoults, 1991:3)

The problem of less favoured regions is considered to be primarily addressed by means of regional policy within the Commission. STRIDE (Science and Technology for Regional Innovation and Development in Europe) a 400 MECU multiannual programme, has been launched in 1990 by DG XVI (Regional Policies), financed by the Structural Funds. The Commission departments responsible for RTD and innovation are less directly involved with cohesion, however in recent years the influence of this principle has grown.

Less favoured countries and regions usually have an economic structure dominated by more traditional industries, a large share of SMEs and relatively few firms with in-house R&D facilities. Such an economic pattern would better match with diffusion-oriented rather than mission-oriented innovation support: enhancing generic technologies that have an impact on a broad range of industries, rather than support the creation of radical innovations in isolated industries, and improving innovation capabilities of existing firms rather than aiming for spin-offs from government led 'big science' projects. As we shall see below the collaboration projects of the specific RTD programmes, proved to attract relatively large companies with established research capacities, usually situated in the most advanced countries of the EC. Because of increased criticism, specific programmes have initiated action lines focused on a better participation of SMEs.

This criticism came firstly from the less favoured countries arguing that their industries benefit less from the RTD programmes. Evaluations and studies showed an unbalanced impact of the RTD programmes in favour of the core industrialised countries (see for instance Roscam Abbing and Schakenraad (1991) on ESPRIT, and Hingel (1992) on all RTD programmes). Peterson also observes that "(...) political pressures from smaller EC Member States, who often lack large, integrated national champions of their own, to spread the benefits of collaborative R&D to a wider coterie of firms (especially SMEs) have clearly had an impact at the intermediate level of the EC's R&D policy networks" (Peterson, 1990:282). Secondly criticism on the picking the winners approach came from countries, notably the UK, arguing that the support for strategic technologies, was treading on the domain of industrial policy, supporting a limited range of industries and enterprises. In this view the 'national champion' approach where large companies were protected by their national governments, was lifted to EC level with the aim to accomplish 'Euro-champions' (Sharp, 1989, Roobeek, 1990).

As a reaction, in the later part of the 1980s, EC innovation policy showed an increasing concern to support SMEs.

The battle over the budgets is illustrated in the recent Council meetings discussing the 4th Framework Programme (FWP). On October 11 1993, France UK and Germany withheld their consent to the proposed budget, during the Research Council in Luxembourg. They considered the Commission budget proposal far too high. While the other countries approved the budget of 13.1 billion ECUS for 1994-1998, the German Minister proposed 8 billion ECU, and the UK and French Ministers called for a budget of respectively 11.5 and 12.5 billion. The main disagreement between the Member States was over support in the Action line for 'promotion and dissemination of research', the most diffusion oriented element in the FWP (tech europe, November 1993). This illustrates the divide between the 'big three' and the smaller and less developed countries, in which the last group is in favour of more

European RTD funds. It is a point for further investigation to see if this is a reflection of an increased 'national competition' in industrial and RTD policies. The final agreement on the budget in April 1994, after three readings under the new co-decision rule, allocated 12.3 billion ECUS to the 4th FWP (Tech Europe, May 1994). Chapter three describes the distribution of these budgets over the main areas of support.

In spite of several policy initiatives outside the Framework Programme, (STRIDE, Human Capital Mobility Programme, regional innovation networks) the general trend is that the core RTD programmes have not been altered under pressure of the cohesion principle. Referring to the two conflicting approaches of EC innovation policy, the dominant approach is that towards the external competitiveness of Europe's 'leading-edge' firms. As we shall see in the next chapter, most budgets are allocated to support strategic high-tech industries or centres of excellence in research. This has led to a concentration of EC RTD activities in the core industrialised EC countries.

We can summarise that in the conflict between the Member States over the budgets and areas of research, the principle of subsidiarity could have a constraining influence on EC diffusion policy (more emphasis on scale effects) while at the same time the principle of cohesion has a facilitating effect (more emphasis on SMEs and mature industries).

2.5 Conflicts within the Commission of the European Communities

The fourth layer of conflict, that between the directorates and services of the Commission is hardly discussed in the vast amount of literature on EC policy in general and RTD policies in particular. It does however have a crucial impact on the implementation of programmes and on the position of diffusion within RTD policies. Unlike most other EC policy areas, RTD policy is a domain in which the Commission has, not only regulatory responsibilities, it

runs programmes and thus allocates funds, which require distributional decisions. The Commission, in particular the offices responsible for the programmes, have a certain autonomy to distribute these funds at the programme and sub-programme level. This creates friction with other Commission services, responsible for the implementation of other EC objectives, directives and principles.

This fourth layer of conflict represents a more fuzzy power conflict that is fought out within the Commission, and deals with the dominance of particular policy domains over others. This conflict is partly determined by the outcome of the conflict in the other two layers, partly result of internal pressures within the Commission. The Commission is not a monolithic block with well defined unequivocal objectives. Policy making at Commission level is a bottom up process where many internal conflicts are settled before the final outcome is presented (Tang, 1992).

"One of the Community's major structural difficulties is that it is multi-layered and there are often no clear lines of authority or of hierarchy between the different layers or levels." (Nugent, 1991: 274)

Proposals for the appropriations of budgets and initiatives for new actions are prepared within the Commission. RTD policy is one of the few areas where the Commission is also responsible for the implementation of the policy instruments. Contrary to agricultural and regional policies where implementation is largely transferred to the national level, RTD policy is part of the Community's 'internal policies', so the Commission manages the budgets, the administrative procedures and the selection of projects. RTD policy instruments are funded through the EC's regular budget thus all Member States contribute financially to the programmes according to the normal distribution principle within the EC (Skoie, 1993). We have to note that in 1992, of the total Commission budget appropriations, RTD policy received only 3.7 %. To compare this to other policy domains, agricultural

policy received 53.1 % and the Structural Funds (regional policy) 27.9 % of the total Community budget (CEC, 1992b).

The main responsibility for the implementation of RTD policy lies with Directorate General XII - Science, Research and Development and Directorate General XIII - Telecommunications, Information Industries and Innovation. These two directorates initiate the proposals for new policies and elaborate the details of existing policies (see also Harrop:1992). A first source of conflict lies between the different cultures between these two 'rival' directorates. The first DG XII, responsible for the operation for most of the collaborative research programmes, has a science oriented culture. The second, DG XIII is responsible for telecommunications policy and for the exploitation and dissemination of research results. Up to 1993 DG XIII was also responsible for the management of the ESPRIT programme, which moved to DG III dealing with industrial policy. Evaluations of the Framework Programme have revealed a rigid bureaucracy and a severe lack of communication between these two directorates. "DG XIII is by nature and outlook '*dirigiste*' with an institutional focus on 'market pull' strategies and technology applications. By contrast, DG XII has a 'looser organization well fitted to academic research' and is more concerned with expanding opportunities for SMEs and 'technology push' strategies (Peterson, 1990:285, quoted from Aigrain et al., 1989:10). We can relate this picture to the approach to innovation and diffusion policy we sketched in the first chapter. DG XIII, largely influenced by the French interventionist tradition, is known for its a 'big-mission' approach, with strategic objectives in a narrowly focused field of technology and a small group of participants, i.e. information technology produced by the 'national champions'. The picking the winners mentality is most obvious in the first years of the ESPRIT programme, when the ties with the Big 12 were very close (Arnold/Guy, 1986, Sharp, 1989, Peterson 1990). For diffusion policy this has significance since this Directorate General has responsibility for 'Exploitation and dissemination of research

results', for which the programmes SPRINT and VALUE were set up. We will see in chapter 5 what the effects on the SPRINT programme are.

The lack of communication with DG XII is an important barrier for the functioning of the other programme, VALUE, since its major mechanism is to spread the results from the collaborative R&D projects, which fall mainly under DG XII. This latter Directorate General described as 'well fitted to academic research' has a tradition corresponding with the traditional linear model. The core of its activities are support programmes for collaborative research. Diffusion is supposed to occur through the collaborative character of projects, with partners from different countries. Chapter 6 on the BRITE/EURAM programme will explore this in greater detail. Thus both the dominant character of the DGs and their lack of communication are a barrier to an integrative approach to innovation, with a clear role for diffusion aspects in that process.

An integrative approach to innovation requires a well co-ordinated policy in which the various aspects, - research, development, diffusion to SMEs, training, strategic innovation management and so forth - operated by different departments are geared to one another. The criticism of a proprietary mentality and the tendency of the programmes to self-perpetuation, that came up in the evaluation of the Second Framework Programme, (CEC, 1992a) confirms the observed barrier for an integrated innovation policy.

The Commission has considerable sovereignty in shaping RTD policy and launching new initiatives, by means of its right of proposals. These are presented to the Council and Parliament and the consultative bodies through the so called Communications.

The process of drawing up official Communications from the Commission to the Council and Parliament, is not a fully publicly visible process. Neither is the preparation of official Communications on each Framework Programme and its specific programmes. Draft versions are prepared by officials in 'horizontal' departments of both DGs. These circulate many times to be

constantly redrafted, first within the DG concerned, then between other DGs involved in the policy matter. Decision making in policy areas which involve more than one DG is even more complicated since the horizontal co-operation between DGs are known to be unsatisfactory (Nugent, 1991:72, see also Cecilia Andersen, 1992, Svein Andersen and Eliassen, 1993). The successive versions of draft communications do not have any legal status. Only the final Communication as published in the Official Documents has official status. The whole process of the internal policy debates thus stays unrevealed. Furthermore "(...) the numerous possibilities for informal influencing, involve an obscurity which makes it difficult for outsiders to follow the ways of the Commission" (Tang, 1992:17, translation PB).

Even within a DG there is competition between divisions where the boundaries of their authority have some overlap. This has caused development of policy initiatives and schemes with similar objectives, but operated from different Commission divisions. These tendencies have caused the Commission to notice that "[t]he programmes are designed within a circle that remains closed. The elaboration of proposals is very unreceptive to outside influences" (CEC, 1992a)⁸.

There are a number of RTD related consultative committees that accompany Commission policy development. The committees have different influence on the Commission's executive power, dependent on their legal status (Nugent, 1991:84-87). The most important ones are the Committee for Scientific and Technological research (CREST) in which the Member States are represented, the Industrial Research and Development Advisory Committee (IRDAC) in which business is represented and the Consultative Committee for the Development of European Science and Technology in which persons are selected on the basis of their reputation in science, technology and

⁸ For a detailed description of the decision-making process in RTD policy see Starbatty and Vetterlein (1990).

industrial matters (Andersen, 1992:238/239). Through CREST the national interests and opinions are passed to the Commission, since its delegates are mainly officials from the research ministries. The president of CREST is the director of DG XII. These committees report on their advice on important Commission proposals and communications.

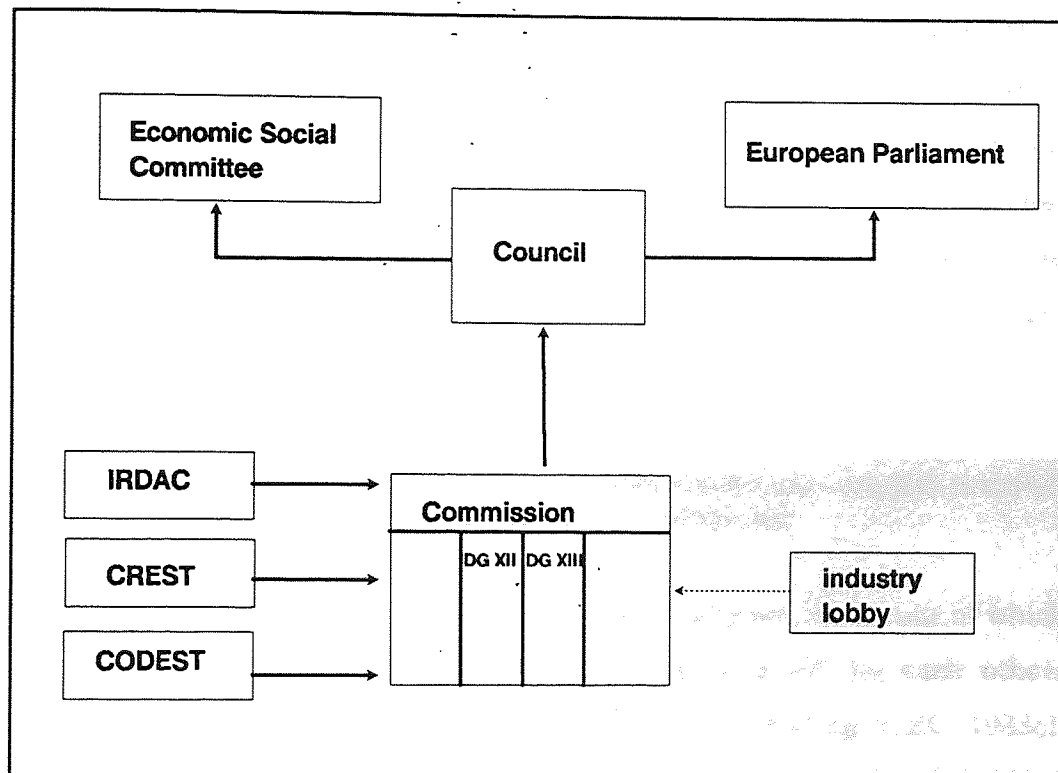
The first three Framework Programmes have been decided upon according to the consultation and co-operation model (Andersen, 1992). The Commission prepares a proposal for the Framework Programme and forwards it to the Council, the European Parliament and the Economic and Social Committee. The final decision of the Council has to be made unanimously. After the Single European Act decisions on specific programmes were made with a qualified majority. The decision making process has changed since the 'Maastricht Treaty' into a co-decision model, a very complex decision model. It implies basically more influence of the European Parliament to reject and amend proposals. The fourth Framework programme is the first piece of legislation on which the co-decision model is applied. It has caused great delays in the decision-making process since there is disagreement between Parliament, Commission and Council on the heights of the budgets and the choice of priority areas (see paragraph 3.5).

Figure 2.3 is a simplified model of the actors in the decision-making process involving RTD policy.

RTD policy is embedded in wider range of EC policies aimed to improve industrial competitiveness. The two related domains that have direct impact are competition and industrial policy. EC competition policy is the responsibility of DG IV, monitoring distortions of competition by firms and national governments. Industrial policy is the responsibility of DG III (Internal Market and Industrial Affairs). Creating an internal market without barriers is seen as the main trigger to boost competitiveness of European industry.

With the Single European Act, ratified in 1987, the Member States committed themselves to complete the Internal Market by 1993, with free movement of goods, services, capital and people. This Internal Market is still far from completed as daily reality of cross border business shows.

Figure 2.3: The decision making process of RTD policies



In the early years of innovation policy, this policy domain is foremost shaped by the regulation of **EC competition policy**. Its objective is to avoid distortion of free competition by high concentration, dumping and unlawful state aids. Because of its primacy, all RTD policies have to comply with the objectives of competition policy, covered in the Treaty of Rome by articles 85-94 (Harrop, 1992:116). Regulation on state aid for research and development is laid down in legislation, its most recent version dating from 1986 (CEC, 1986b). It sets the boundaries in which national governments can support their industries and research without the distortion of competition. These rules also

apply to Community support mechanisms and programmes. EC RTD support programmes most frequently involve international collaboration between research institutions and firms. Often more than one firm participates within the consortium that is created for the project. These firms could be direct competitors, could have a supplier relationship or could be simply interested in the same field of technology for different purposes. This firm to firm collaboration is at the heart of competition policy concern. Article 85 of the Treaty of Rome forbids all agreements and concerted practices which affect trade between Member States and restrict competition. Under this rule, agreements between firms as "... exchange of information between competitors" is forbidden (Andersen, 1992:106). However the Commission has been lenient with this rule if it concerns collaboration for R&D. The Commission's answer to this problem was to restrict R&D collaborative activities to pre-competitive research.:

"There can be no doubt that the Community should only support research which is pre-competitive in nature." (CEC, 1992a:16)

This means that firms can perform joint research projects, the results of which can be used equally by the participating firms, who will be each others competitors in stages of product development and marketing (CEC, 1983c). To implement these rules to judge the legitimacy of national support mechanisms, the Commission has defined four phases of research activities:

- *fundamental research*, which can be supported without problems;
- *basic industrial research*, which can only be supported up to 50 % of project costs;
- *applied research* (up to the stage of prototype design) and *development* (only demonstration projects), of which allowed support percentages decline when projects get closer to commercial introduction. This is dependent on Commission judgement in each case (CEC, 1986b).

The EC rules are applied more and more strictly in recent years at the national level. It assumes that the research phases of the type of projects supported can be clearly distinguished. The integrative model suggests that the borderlines between these phases are not so clearcut. In addition, these rules force policy makers to define the activities eligible for support, in the 'upstream' regions of innovation. Observing the rules has led national governments to become creative in finding ways around them. One effect has been a revival of tax incentive and loan schemes, since these indirect measures are not judged with the same scrutiny as direct subsidies to firms (Fahrenkrog, Selman, Boekholt, 1993). At the European level, we can see an opposite trend: the pre-competitiveness regulations are relaxed from the late 1980s. In chapter 3 and 6 we will see that the Commission tries to find ways around the strict interpretation of 'pre-competitiveness'. In the 1993 White Paper 'Growth, competitiveness and employment', one can read that:

"Implementation of the guidelines proposed will also call for changes in the rules and instruments for Community research. In practice, there are clearly limits to the single formula of 50 % funding of costs of pre-competitive research projects. Formulas creating a more flexible link between project-funding and the obligation to produce results, tailoring the level of public support to the economic and social importance of the results, will have to be explored." (CEC, 1993a:91)

This shows that even the Commission is looking for support mechanisms to avoid its own rules. Of course, in the same section in the report it is stressed that steps have to be taken to ensure that the measures are compatible with competition policy and agreements on state aid.

The state-aid regulation has consequences for EC at the programme level as well as on the project level. At the **programme level** the emphasis has been laid on R&D areas that have far more to do with the 'R' of research than the 'D' of development. Programmes as ESPRIT and BRITE were defined to support mainly 'upstream' research. ESPRIT had some elements of applied research but the 'pre-competitive' requirement prevents projects from moving

too close towards product development. In this way it also effects the selection of projects eligible for Community support. Projects that have the potential to get too close to the market are not selected by the expert committee as we shall see in the case of BRITE in chapter 6. The Commission argues that results that could come out of the ESPRIT projects, should be pursued to near market status within the EUREKA programme, the European collaboration programme that falls outside EC jurisdiction.

The ambiguous way in which the EC deals with the concept of pre-competitiveness becomes clear in a draft Commission communication on *Research After Maastricht*:

"But what is the definition of pre-competitive research? Pre-competitiveness applies to those RTD activities which private companies can carry out jointly, before separately developing and marketing their own products. ... Whilst this is perfectly clear conceptually, the demarcation line between pre-competitive research and product development research is, in practical terms, rather flexible." (CEC, 1992d:18)

The first sentence, which is printed in italics, was left out in the official version published after consultations with the Council and Parliament.

The uneven course between stimulating competitiveness through innovation while remaining pre-competitive in the implementation of this policy has reinforced the tendency for 'technology push' programmes. The idea behind this is that stimulating up-stream, 'generic' technologies will lead to down-stream competitive advantages. This approach blocks possibilities of involvement of potential users of the new technologies. The main challenge is to bring about this flow from up-stream to down-stream: the most troublesome aspect of EC RTD policy. In evaluations of various R&D programmes so far a lack of clear commercial successes has been a recurring point of criticism (CEC, 1988c, Esprit Review Board 1989). The pre-competitiveness principle thus hampers the key objective of RTD policy: enhancing competitiveness of European industries.

At the **project level** the effect is that:

- the definition of technological areas and the uncertain commercial potential compared with the effort and resources a firm has to put into a collaboration project, has made the EC programmes mainly attractive for firms with large R&D resources. Some evaluators have noticed that large firms often use EC R&D programmes as an 'insurance' for future developments: not their most strategic research projects will be put forward in collaborative projects, but those research topics surrounding their core technologies, which they expect could play a role in the future (Guy, 1992). This forms an additional discouragement to develop and commercialise the results of the R&D programme.
- SMEs are badly represented in EC RTD programmes. Firstly most SMEs are less interested in projects where the commercial potential cannot be attained in the short or medium term. The science oriented contents of many research projects do not match with the R&D resources and commercial constraints of many of these firms, except for a relatively small population of small high-tech firms. Secondly many individual SMEs have difficulties finding the financial resources to participate in these large scale projects.

Thus a strict application of the pre-competitiveness principle moves projects away from diffusion-oriented phases of innovation. In chapter 6 we will see what the practical implications are in the case of BRITE/EURAM. We will explore if this programme which is potentially diffusion-oriented is 'pushed upstream' by the principle.

A second EC policy area that has an impact on RTD policy is **industrial policy**. Industrial policy in the eighties was a 'forbidden' concept for many governments, after bad experiences with large scale support efforts to save already withering industries, such as textiles and shipbuilding. The failure of these policies to save the industries for the European countries became

evident in the late 1970s and early 1980s. "With that recognition came a lull in industrial policy, coupled with the ideological shift away from interventionism that characterized economic policies in most industrial countries during the 1980s" (Nicolaides, 1993:1).

In the 1980s the EC has hardly any instruments to implement an interventionist type of industrial policy, except for the industries falling within the ECSC Treaty. There is no substantial procurement policy, and direct interventions into industrial sectors or firms are few. The instruments are of a general nature: regulations on competition and the internal market, trade policy and standardisation. In fact RTD and telecommunications policies are the main interventionist instrument the EC has, except for the past interventions in mature industries like steel, textiles and shipbuilding.

In the late 1980s the question whether the EC should extend its role towards a European industrial policy started to reappear in the policy debates. In these debates between the 'interventionist' and the 'liberals' in the Commission the last group seemed to be at the winning end in the 1980s. DG III responsible for industrial policy was 'stuck in the middle' between the 'dirigiste' and French oriented DG XIII and the 'liberal' British oriented DG IV. For the liberals, mainly seated in DG IV, innovation policy is industrial policy in new clothes. The debate reached a climax around 1990-1991 when both DG III and DG XIII initiated a strategic document on their future policy. The first was a strategic document 'Industrial Policy in an Open and Competitive Environment' - acting as a statement of intent - on industrial policy, published by the Commission in 1990 (CEC, 1990b). It is also known as the 'Bangemann Report', named after the Commissioner who instigated the document. The document is a compromise between the liberals and the interventionist, which was striking since DG III had the reputation of an interventionist approach. It posits that no sectoral interventions should be taken, only 'general' measures to improve the environment for competitiveness. RTD policy is seen as the most important instrument to support industry without having to take

any sectoral measures. In this Commission communication, the capacity to master efficiently the diffusion of technological innovation is put forward as one of the main challenges for EC industry. It states that industry has to make best use of the potential and the results from technological research and development undertaken in Europe, alongside achieving a better balance between supply and demand for goods and services. The measures to be taken for this account are, amongst others, increasing the pre-competitive research effort, the promotion of transfer of know-how from basic research through to industrial application by assuring access to that knowledge and training. Diffusion in this line of thinking follows the traditional linear pattern.

This approach was approved by the Council in November 1990 (CEC, 1991a). The practical consequence for RTD policy was that the objectives were to be articulated, strictly in terms of policies for 'generic technologies', i.e. technologies with a broad impact on a number of industries.

In december 1991, when meeting to draft the Maastricht Treaty, the European Council, decided to give the Community for the first time explicit competence in industrial matters (Nicolaidis, 1993). The difference with the industrial policies of the 1970s is that now it focuses on the strategic high-tech sectors of electronics and telecommunications. In this political battle, DG XII and XIII do their utmost best to avoid the appearance of conducting a 'vertical' supportive policy (Den Hertog and Leyten, 1991; P.E. de Hen, 'Bangemann loopt op eieren', (Bangemann walks on eggs) Financieel Economisch Magazine, july 1992).

In a reaction on the aforementioned communication on industrial policy, DG XIII released a communication on the information and electronics industry in "The European electronics and information technology industry: state of play, issues at stake and proposals for action" (CEC, 1991a). The document applies the concept of industrial policy to the information technology and electronics industry. Increasing criticism on the lack of obvious success of the large scale support for these industries have triggered the debate on the character of this policy area. One part of the discussion centred

on the 'picking-the-winners' philosophy in the ESPRIT programme. After all, the 'Big 12' received 50 % of the total ESPRIT I budget and were involved in 70 % of the projects (ESPRIT Review Board, 1989:12). The fiercest criticism though was on the fact that the programme had not led to an improved competitive position of the electronics industry and the projects lacked commercial potential. With the backing of the renewed competence in industrial policy, the DG XIII communication announced the launch of projects "geared more closely to the market. (...) This second generation should be characterized by the concentration of work on a smaller number of better targeted and more ambitious objectives, closer cooperation with users, provision of training linked to advanced research and opening up to international cooperation" (ibid.:4). This reveals a relaxation of the strictly applied principle of pre-competitiveness, a shift that increases the possibilities for more diffusion oriented projects. At the same it reveals a tendency to move back to more 'mission oriented' ambitious projects, probably in close consultation with the 'Big 12' again, since the former 'National Champions' still have extensive lobbying powers.

The confirmation of an increased industrial policy element in RTD is stated in the Maastricht Treaty, which strengthened the industrial dimension of RTD policy. In Article 130 under the title of Industry it is declared that the Community and Member States actions are to be aimed at fostering better exploitation of the industrial potential of policies of innovation, research and technological development (CEC, 1992a:8). The interpretation of this article in the Maastricht Treaty led to a conflict of opinion between the Commissioner for Research Policy, Mr. Ruberti and the Commissioner for Industry Mr. Bangemann. In an interview with Europe Information Service, Mr. Bangemann stated that he favours a 'bottom-up' approach from industry toward the political level, "(...) both at the design stage and when the time comes to submit projects". Mr. Ruberti on the other hand has stated that "the Community should not adopt a "bottom-up" approach when selecting research

programmes, (...) for this would enable companies to propose their own ideas rather than respond to EC initiatives" (tech europe, April 1993). At this moment, Mr. Bangemann had obtained the authority over the ESPRIT programme, because responsibility for information technology was transferred from DG XIII to DG III in 1993. This is exactly the domain where industrial policy, competition policy and RTD policy encounter each other most directly.

In proposals and communications the Commission describes its RTD activities rather in terms of indirect firm support. It claims that the main role for the public authorities in the innovation process, which is essentially the responsibility of firms, is to "bring about the creation and maintenance of an overall economic "environment" and a respect for free competition, which is necessary so that firms can effectively develop supply policies" (CEC 1992a:17). This explains a preference for stimulating 'generic' technologies which have a horizontal impact and cannot be designated to a particular industrial sector. The idea behind this is that these up-stream, cross-sector generic technologies will have an impact on down-stream competitive advantages. The Commission words the developments as follows:

"During the last two years, and after a marked absence in the 1980s, the idea of a need for a European industrial policy has reappeared. In the 1970s industrial policy was characterized by a *dirigiste* and sectoral approach. Today, it is recognized that public intervention in this area must take the form of horizontal activities (...) the Council adopted a resolution on 18 november 1991 applying this concept of industrial policy to the information and telecommunication technology sectors. Moreover this approach has been formally endorsed at Maastricht." (CEC, 1992a)

Regional policy and policy for SMEs, coming within the area of responsibility of DG XVI and DG XXIII, developed their actions independent of RTD policies. In recent years attempts are made to increase co-operation between these two policy areas and RTD policy, however there are still few joint initiatives. Regional policy has been dominated by efforts to improve the

physical infrastructures in the less favoured regions, such as telecommunication networks, roads and so forth. In the 1990s EC policy makers in the Commission became aware that arrears in technological capabilities is an important cause of the lag in economic development. Through the Structural Funds major schemes were designed to make up for these arrears. The STRIDE programme is one of the first major initiatives. The case for better access of SMEs in the core RTD programmes, has been translated into a few sub-programmes which address their specific needs. In chapter 6 we will see what this has involved in the case of the BRITE-EURAM programme. However systematic co-operation between policy makers in the RTD areas and those in SME areas seems non-existent. The aforementioned development of various resembling and overlapping regional networks set up by the different Commission services (paragraph 2.3) illustrates how these services attempt to 'claim' a certain type of policy action, rather than to join forces.

The description of the decision-making process allows us to conclude that the Commission is a key actor in shaping Community RTD policy. However we should not see it as a monolithic block, but rather as a political community in which different policy networks operate.

2.6 *Conclusions: opposite forces in the policy context*

Several recent developments have led to the need of rethinking the role of the Community :

- competitiveness of European industries has not improved substantially despite large public efforts in research and development;
- the entry into the EC of Member States with less developed innovation capabilities has accentuated the choice between a selective policy supporting competitiveness of the leading edge high-tech industries versus a policy supporting the innovative capabilities of industry in general;

- the re-emergence of the debate on subsidiarity has revived the question of the appropriate level of intervention.

Commission policy has to reconcile the opposite pressures resulting from these developments. We have seen that Peterson (1991) presents three levels of policy networks that reveal power dependence relations: competition between the Commission and national governments, competition between Member States for scarce policy resources and finally Commission-industry alliances. The latter was left outside the scope of this study.

The study of the development of technology policy shows there is another decisive dimension: the intra-Commission policy networks and power relations. This has been a neglected factor in many studies of EC policy, where the Commission is considered as a monolithic block with one rational view on policy strategies. The intra-Commission conflict partly reflects the conflict between Member States and their concepts of government regulation vis-à-vis industry. We have seen that General Directorates within the Commission are each influenced by a particular national style of regulation. We have also seen that these conflicts have similarities with power conflicts in every national bureaucracy, where ministries and government departments fight over competencies and budget allocations. It adds another dimension in the policy context in which innovation policy is embedded. The four layers of conflict have both positive and negative effects on the transition to an integrated approach and diffusion oriented policy.

At the level of conflict between Member States and Commission restricted competence over industrial policy formed the major constraining factor to launch diffusion oriented programmes. The Commission was not allowed to support activities that would influence a firm's or sector's competitive position in the short term. The sensitivity of industrial policy at EC level was due to the fact that many Member States wanted to keep national authority over this area. In other countries it was rather the philosophy of non-intervention in

industry that made intervention in industry a forbidden area for the Commission.

In the late 1980s both the commitment to a European industrial policy grew and the dominance of competition policy relaxed, which made support for 'near market' activities more viable.

The matter of social and economic cohesion on the other hand was a power issue between the less favoured versus the industrially developed countries in the EC. A change in the balance on the issue in favour for cohesion, was a facilitating factor for a diffusion approach since diffusion would increase the flow of innovation capabilities from the core to the less favoured regions. It forces the Commission to say that "its strategy for research and development should contribute to this objective (...) in helping to strengthen scientific and technological infrastructure and potential throughout the Community" (CEC, 1992a).

In addition, it increased the call for policies for SMEs and mature industries, following the growing criticism that SMEs do not have access to the Community's R&D programmes. The Commission has increased efforts to change that through numerous accompanying measures to involve SMES in the projects.

The Commission seems increasingly aware that supporting innovation implies more than funding of basic research, however it is still uncomfortable to act on this insight. However the above mentioned developments could provoke a shift away from the science led technology programmes aimed at the 'high-tech' industries, to allow for more participation of firms and industries with a focus on application and design related technological problems. We have seen in chapter 1 that mature industries rely heavily on diffusion of process technologies to sustain their competitive position. Innovation policy with a cohesion contribution implies an enhancement of the innovation and diffusion capabilities in a wider set of industries and of the institutional infrastructure that supports innovation.

Together, the increased commitment to a European industrial policy, to socio-economic cohesion and the case for better access of research to SMEs, have had an influence in favour of diffusion oriented policies. This has outweighed the opposite influence that competition policy and the inclination to move back to large scale, mission oriented projects had in recent years. Overall, in the European policy context of RTD actions, the balance has shifted in favour of diffusion oriented policies. If this has subsequently led to increased actions and budget allocations in this direction, will be investigated in the next chapter. On the other hand, given the conflicts of objectives, and the lack of cooperation between the different Commission services, we must conclude that an integrated approach to innovation, which needs an integrated policy strategy and vision, seems unlikely to emerge in the short or medium term.*

3. IMPLEMENTATION OF EC INNOVATION POLICY: THE PRIORITY AREAS

3.1 Introduction

Chapter 1 described the shift of innovation policy from a linear approach toward an integrative approach. The success of both the Japanese and German system of innovation inspired analysts to look at the determinants behind this success. The shift first occurred in innovation literature and slowly policy makers in numerous industrialised countries were persuaded by the insights of the analysts. In this chapter we will analyse if there has been a similar shift of approach in the innovation policy of the European Community as can be observed at the national level.

If we want to assess the degree of 'diffusion orientation' in EC RTD policy we first have to recall the taxonomy of key elements presented in the first chapter: concern for the non-technological elements of innovation, support for more 'near market' research projects, projects embedded in a wider innovation strategy, support for technology transfer, dissemination and standardisation, concern for innovation in a wider set of industries instead of targeting on narrowly defined technologies and their producers, and stimulating formal and informal networks (see paragraph 1.4.2). Decentralisation in implementation, goal-setting and distribution of funds, are considered by Ergas (1986) as key concepts of diffusion policies. We have also seen that diffusion policy inspired by the linear approach focuses on other public efforts than in case of an integrated approach.

We will assess in this chapter the position of diffusion oriented support mechanisms in EC innovation policy, compared to programmes that reflect either a clear mission approach and/or stemming from the traditional, science-push model of innovation. To stress the historical shift that has taken place,

in the 1980s and 1990s, the emphasis of analyses will be on the priority areas in the so called *Framework Programmes*, the multi-annual planning programmes in which EC RTD policy is embedded. However, since present policies are determined by past developments, a short historical overview is given of the period before these Framework programmes were launched.

3.2 *Before the Framework Programmes*

The legitimacy of science and technology policy at the European level is only very recent, as was mentioned in chapter 2. The 'Single European Act' of 1987 was actually the first EC act that explicitly contained paragraphs on technology and research policy. Far before this date collaborative R&D was supported at European intergovernmental and EC level. Intergovernmental co-operation in industrial projects focused on aerospace, with numerous ambitious projects such as the Anglo/French Concorde and the Airbus programmes (Maciotti, 1975:299). At Community level R&D cooperation was restricted to the areas of coal, steel and nuclear energy, those areas in which the Community had competence as a result of the three treaties that brought the European integration into being. These were the European Coal and Steel Community (ECSC) of 1951, the European Atomic Energy Community Treaty (Euratom) and the European Economic Community Treaty of Rome, both of 1957. The countries involved in that time were Belgium, the Federal Republic of Germany (FRG), France, Italy, Luxembourg and the Netherlands. The first European R&D projects in steel-making, coal and ore mining, as well as health and safety problems, were part of the European Coal and Steel Community. This system of support for research activities for these two sectors was developed in 1955 and existed until the mid-1980s. No detailed provisions were given how these funds were to be spent. The ECSC Treaty in fact does nothing more than encourage technical and scientific research aimed at increasing efficiency and safety in the iron and steel industry (Maciotti, 1975,

CEC, 1985b). The Commission of the European Communities only acquired competence over these areas with the merger of the three Treaties and subsequent Commissions.

The European Economic Community Treaty of Rome contained hardly any provision for Community Research, only for research intended to boost agricultural productivity. The Euratom Treaty offered the widest scope for research and development activities (CEC, 1985b:10). As part of the treaty a Joint Nuclear Research Centre (JNRC) was set up to carry out collaborative nuclear research. The centre had four geographical sites, in Italy, Germany, Belgium and the Netherlands (Macioti, 1975).

Ford and Lake (1991) express that it is interesting to have a closer look at this Euratom Treaty and its research aspects, because it has had an important impact on recent EC technology policy. The first point that is remarkable about Euratom is that it gives considerable centralised power to the Commission for its implementation. Funding and research were centralised and the programmes were essentially science and technology driven. Therefore the JNCR could lead its own life, without any assessment of the need of their research. The European Parliament had not much say into it. No independent evaluation of the programmes took place. Although one can say that this only concerned the nuclear energy programmes, the weight of this programme and the amount of funding was, and still is profound, as we shall see below. Centralised research in nuclear energy turned out unsuccessful. Nuclear research remained a thoroughly national activity and the JNCR's reactor designs did not work, according to the authors.

Within the scope of the EC Treaty science and technology policy emerged on a very small scale. The debate was triggered by literature on the 'American-challenge' and the 'technological leeway' that came up at the end of the 1960s. The PREST group, an offshoot for science and technology of the principal EC Committee on Economic Policy, initiated the discussion on the advantages and

conditions for a European science policy. In a 1967 report one of the conclusions was that a link should be established between research policy and industrial policy. The emphasis resulting from these discussions shifted to the definition of cooperative action in seven fields of science and technology: computers, telecommunications, transport, oceanography, meteorology, metallurgy and pollution (Macioti, 1975:303). In 1970 the COST programme (European Cooperation in Science and Technology) was launched by the Community of the six, aimed at collaboration with third countries that were advanced in certain scientific or technological fields. A wide range of collaboration projects were set up within the framework of this programme. EC direct involvement was small: it provided the administrative, technical and scientific support necessary for the preparation of the projects, carried out as concerted action. In 1972 the Commission put forward further proposals for a common R&D policy but although the reports aroused lively debates within the Member States "their implementation did not progress very far, essentially due to the reluctance shown by Member countries in delegating the necessary powers to the Community and its institutions" (Macioti, 1975:305). One of the actions was the UNIDATA-project, an attempt to bring Siemens, CII and Bull together to develop a European computer industry. This project turned out to be a large failure (see Sharp, 1989:207 and also Roobeek, 1988:157).

The actual starting point of EC research policy was in January 1974, when the Council of Ministers decided to extend community research activities to all areas of scientific and technical research. It gave the Commission the authority to gradually extend its co-ordination activities of national policies (Macioti, 1975, CEC, 1981). The first science and technology action-programme was launched. The focus of this action-programme was on efforts to coordinate the national science and research activities. According to Macioti (1975), director of Science Policy of the EC, the actions in industrial fields were few, despite proposals and guidelines put forward by the Commission. "Unfortunately, not many of these schemes have so far met with enthusiasm in the Council: in the

Summer of 1974, only a statement of intent had been approved for a common policy in data processing (Macioti, 1975:306). The Commission was assigned to set up several large sectoral research programmes (CEC, 1988a:18). These sectoral areas were energy, environment and materials, which later emerged into Research Action Programmes. The article in the EC Treaty (Article 235) on which this decision was based, made Community action subject to a unanimous decision by the Council of Ministers. Each action in the research field needs its own legal basis in the form of a unanimous decision by the Council (CEC, 1985b:10). These first action programmes set the foundations for EC science and technology policy.

By the end of the seventies the Commission had three instruments to implement its research policy:

- contracted research with cost sharing (usually 50 % of a project is paid by the EC);
- concertation of national research activities (reimbursing coordination costs);
- the Communities own research in the Joint Research Centre.

At that time the distribution of research funds over the 'research sectors' were energy 70 % (1978), raw materials 2.3 % (1978), agriculture 1.1 %, industrial competitiveness 6 % (1979), life conditions (health and labour conditions) 6.7 % (1978) and environment 5.2 % (1978) (CEC, 1980). The programmes developed in these years were a jumble of small, inconsistent and incoherent programmes (Pelkmans, 1988:276-277).

A 'horizontal' programme set up in the seventies was the FAST programme (Forecasting and Assessment of Science and Technology), launched by the Commission and Council in 1978, to assess long term effects and developments of new technologies. This programme launched numerous study reports on issues relating to science and technology.


In innovation literature, national policies in the sixties and seventies are described as policies inspired by a science-push theory of technological development. National policies aim to support - mainly fundamental - research, as research is seen as the main source of innovations. The EC innovation policies up to the early eighties, has a similar approach, since the main aim of the support schemes is to support collaboration between national research institutes and setting up research centres itself. It is more appropriate to label EC efforts in this period as science policies rather than innovation policies, due to the focus on scientific research collaboration. Gradually during the 1980s the emphasis shifts from science policy to an industrially oriented research policy⁹. Innovation at the firm level was hardly an issue in the 1970s, it was something that would 'automatically' follow from these research efforts. This is confirmed by the very small share (6 %) in the budget for research aimed at improving industrial competitiveness. It is likely that commitment towards the EC at that time, was not strong enough to create programmes that related to such vital issues as the competitiveness of national industries. Another point that played a role is the notion that EC policy makers considered cooperation in research not only as an aim in itself but, for a large part as a means to reach a higher goal: political integration of the Member States. In the official EC documentation on research policy it is clearly stated that "(M)any forms of policies fall under the EEC, which aims in everything at one goal: the integration of Europe. Within this research is a means" (CEC, 1980:5).

Rothwell and Dodgson (1990) argue that at the national level the science-push philosophy of the sixties and early seventies gradually shifted during the late seventies towards more market oriented 'innovation' policies. Industries were

⁹ A striking illustration of this shift is the CEC's promotional publication every few years, which was titled *The European Community's research policy*, in 1980 and 1985. In 1988 for the first time this is changed into "*The European Community's research and technological development policy*" (CEC, 1980, 1985b, 1987a).

given a larger role in the support of R&D and innovation-stimulating public procurement was used. Despite this increased attention to the demand-side of R&D, it still had a technology-push philosophy. A similar shift at EC level started only in the early eighties. At that time, several new programmes were set up in areas like information technology, bio-technology and materials with the name Research Action Programmes (RAP). These programmes had two specific characteristics: participation from universities, research centres and companies; resources from several disciplines were combined; and the implementation usually took place in the form of transnational projects. The main idea behind this was to ensure integrated management of different types of policies in the same field of research. The following table gives the amount of EC financial contributions to the RAP research fields in 1981, 1982 and 1983.

Table 3.1: Amount of EC financial contribution in MECU and percentage of total funding by field of research in the years 1981 to 1983



Aston University

Content has been removed for copyright reasons

* Funding on "Joint European Torus", a model fusion reactor in Fulham, UK, is not included in this table. Funding was 219.5 MECU over these three years, almost equal to all other programmes taken together.

Source: Compilation of figures CEC, 1985a:17)

From this figure we can clearly see that energy research and in particular nuclear energy, still had the highest priority in EC policies up to the early eighties. In the 1984 budget, 72 % was allocated to energy research, 9.7 % to industrial sectors, 8.4 % to environment, 2.3 % to raw materials and 1.1 % to agriculture (CEC, 1985b:19).

We can draw several conclusions from these early phases of EC technology policy:

- The focus was on coordinating science and research, innovation in industry was a secondary concern.
- The bulk of the funds clearly went to 'mission oriented' policies with an emphasis on large strategic projects, particularly in nuclear energy.
- The most important part of EC R&D projects were organised and funded in a centralised manner. As we have seen from Ergas this too is a characteristic of mission-oriented policies.
- There was hardly any spin-off to the rest of the economy or other technology areas.
- In those cases where industry was involved in the programmes, they were usually mature industries like coal and steel.
- Especially the nuclear energy programme and later thermonuclear fusion, were exponents of both a traditional linear model of technological innovation and the 'mission oriented approach: 'big-science' will eventually lead to new innovations.

3.3 *The first Framework Programme*

The real boost in RTD policy was triggered by Commission communications proposing a common strategy for the 1980s. The first of these Communications "Science and technological research in the European Community, Proposals for the 1980s" was put forward to the Council and European Parliament in October 1981 (CEC,1981). As a result the Council asked the Commission to

design a first Framework Programme. Framework Programmes are the EC's multi-annual (usually 4 years) planning outlines, which set the main priority areas for EC support, including the allocation of budgets over these areas. They are described either in terms of technological fields or in terms of missions, such as "improving the competitiveness in industry". The first proposal for a Framework Programme was offered in January 1983 and revised in May 1983 (CEC, 1983a and 1983b). The main conclusion of all these documents was the necessity of an increased EC effort in science and technology. The key argument was a relatively weak R&D effort in Europe compared to the United States and Japan. Figures on R&D spending and the number of scientists and engineers in each of these areas provided the evidence. The 1981 communication gave four underlying reasons for the scientific and technological lag with the competitors US and Japan:

- a slow development of the organisational structure of government research, especially university research;
- an overlap in research activities in the Member States leading to a fragmentation of efforts;
- a lack of stimulating factors for research that has a broad impact on industry and for valorization of results of basic and applied research;
- insufficient links between university and industry.

It is clear from this summing up of factors that the main source of 'failure' is sought in the lack of effectiveness in research and especially university research. It is not that Europe is judged to be weak in science, on the contrary. The problem is that Europe does not manage to translate its strong science position into industrial success. One of the proposed action lines to increase the effectiveness of European researchers is to stimulate their international mobility and scientific publications in European journals. However, this action line was attributed only 2.3 % of the RTD budget (see table 3.2).

The Council reached the conclusion to step up Community action by means of strengthening the existing programmes and the establishment of priority areas for long-term R&D involvement. The influence of the then Commissioner Etienne Davignon gave an important impetus to the increased vigour (Arnold/Guy, 1986:103-104, Sharp, 1989:208). He was very much involved in the launch of ESPRIT (European Strategic Programme for Research and Development in Information Technologies). "The formation of an Information Technology and Telecommunications Task Force (IT Task Force) within the European Commission in 1983 provided the institutional underpinning to support the formation of industrial policy for electronics within the EEC" (Arnold/Guy, 1986:102). This Task Force was initially set up as a department of DG III for Industrial Policy, with Davignon as responsible Commissioner. Information technology is considered to be the key technology which determines Europe's competitive position towards the US and Japan. "The announcement of the Japanese Fifth Generation Project (5G) in 1981 served as a catalyst in policy formulation world-wide for advanced information technology" (Arnold, Guy, 1986:7). Indigenous production of microelectronics is seen as essential not only for the IT industry, but also for the competitiveness of all other industries. "The belief that all industries which are becoming dependent on embedded microelectronics can develop competitively by purchasing standard components from remote and competing nations is fallacious" (Esprit Review Board, 1989:13).

It took until 25 July 1983 for the Council of Ministers to decide to build the EC R&D strategy around Framework Programmes along the lines that the Commission had drawn in its proposal.

"The purpose of such programmes, which must outline both the scientific and technical framework and the financial implications, is to set a number of objectives to serve as references for Community sector policy and research schemes." (CEC, 1985a:10)

Glyn and Lake stress that this Framework Programme was launched in an attempt to render coherent its disparate R&D programmes (Ford/Lake, 1991:46). Policy makers indeed regard it as a tool for medium-term programming to assign broadly defined research areas. The details of the programmes would be laid down in the design of specific programmes that fall under each priority area. To allow for uncertainties in the business cycles and in science and technology, the four year Framework Programmes would be reviewed every two years to see if amendments are necessary.

The Framework Programme was not only a policy implementation tool for medium-term programming and financial planning, the Commission considered it also as a platform to discuss and co-ordinate national initiatives and actions as well as developing common initiatives (CEC, 1981:15). This role as "linchpin of national policy efforts" (CEC,1981:23) which was ascribed to the Commission in 1974, could not be played due to a lack of actual power. The Commission was hoping the Framework Programme discussions would provide them a foothold to play this role more effectively.

The first two levels of political conflict, between the Member States and the Commission and between the Member States themselves, come together in the negotiations on the Framework programmes. First there are the discussions in the Council meetings on the height of the research budget. The positions depend partly on the attitudes of the nation states: is EC RTD policy seen as an addition to national policies or as a replacement? (Skoie, 1993) Some countries, in particular Germany and France want to sustain considerable budgets at the national level, to fulfil their own strategic aims. For the smaller EC countries the activities in the Framework Programme provide an opportunity to keep in touch with R&D areas in which they cannot afford a large effort at the national level. Subsequently negotiations take place on the distribution of the funds over different research areas, dependent on the nation's own industrial and research strengths.

With the design of Framework Programmes, the EC focuses on particular themes since its fundamental principle is "... not to transfer to Community

level as much scientific and technical work as possible but to concentrate on those activities in the Member States in which European cooperation offers obvious advantages and will generate a maximum of beneficial effects" (CEC, 1988a:5). We have seen in the previous chapter that the subsidiarity principle became even more important in the 1990s.

The aims of EC technology policy can be reconstructed from the general phrases and statements in official documents and communications, however the specific schemes and their budgets reveal the actual choices made for certain support areas.

Contracted research, where the EC pays up to 50 % of the research costs, is the main support mechanism in the Framework Programmes. The contracts are given within the specific programmes of the Framework Programme and some 80 % of the financial resources fall under this category.

The first Framework Programme covered the years 1984 - 1987 and was provided with a budget of 3,75 billion ECU. Although this was an important increase in the total budget for R&D, the share in the overall EC budget however was still only 1.63 %. The distribution of funds in the first Framework Programme are shown in table 3.2.

The titles of the themes are the main policy strategies for the 1980s as defined within this Framework Programme. The choice of these themes and their share in the budget seems to be mainly motivated by historical presence: those areas that already existed were strengthened. Energy is still the most important sector of research funding but its share has decreased considerably compared to the period of 1980 - 1983. Striking is the sudden rise of industry related funding, especially the new technologies (18 % of funding), of which the information technology programme ESPRIT has the largest share. Another programme that has been launched as part of the First Framework Programme is BRITE (Basic Research in Industrial Technology for Europe)

stimulating technologies in conventional industries, discussed as a case in chapter 6.

Table 3.2: Funding in the first Framework Programme (1984-1987)

<i>MECU</i>	<i>Percentage</i>
-------------	-------------------



Aston University

Content has been removed due to copyright restrictions

Source: The European Community's research policy, EC Department IXD5 - Co-ordination and preparation of publications, 1985.

So we see that from 1983 onwards there is an increasing industrial content in the RTD programmes. The choice is for 'strategic industries' and 'strategic technologies' in particular information technology. We can notice a shift from a pure science oriented policy towards an R&D policy, involving more industrial partners in the projects. In 1984 the Commission has three priorities in improving competitiveness of industry:

- lifting of trade barriers through uniform standards and measures;
- modernising of traditional industrial sectors by R&D in generic technologies mainly for car manufacturing, tool industry, nonferrous metals, transport, chemical, steel and textile industry;
- stimulating and developing new technologies in particular information and bio-technology (CEC, 1985b:17-18).

Thus its RTD policy combines support for both the mature industries and the state-of-the-art strategic technologies. The distribution of funds reveals that this last category is clearly dominant.

3.4 *Towards a European Technological Community*

In order to establish the gained weight of its role in RTD, the Commission published a Memorandum "Towards a European Technological Community" in June 1985 (CEC, 1985e). In this document the analysis of Europe's problems has not changed: European industries and especially the high-technology industries are behind its main competitors in the US and Japan. This is shown in a decline of the trade balance for high-technology products. The EC analysis of the main reasons behind this has changed emphasis: a fragmented market, a lack of a common RTD strategy and dispersion of R&D budgets because of holding on to national efforts. The ineffectiveness of European research, which was the reason for the European leeway in 1981, is not so prominent in the 1985 analysis. The lack of a coordinated European RTD policy is the main evil. The creation of a "European Technological Community" would help to set aside all these factors. The Commission benefited from an upsurge of Euro-optimism, triggered by the White Paper '*Completing the Internal Market*' published in June of that same year (CEC, 1985g).

The memorandum was a plea for a firm integration of RTD policy in the wider Community objectives, in particular the completion of the Internal Market, the Community's trade and competition policy. Furthermore it stressed the need for a better co-ordination of national, intergovernmental and Community efforts. This includes more flexible possibilities to participate in multilateral collaboration projects such as Airbus. To achieve this it appealed for the legitimization of Community authority in this policy domain.

The document put forward three types of programmes to implement RTD policy: research for generic technologies, large collective installations for fundamental research and strategic programmes. In this last type of programme the research and development phase is only the preparatory phase for public procurement and exploitation. The Commission referred to projects in the area of telecommunications, aerospace and social use of products based on information technology. It thus provides "a critical mass of public procurement in strategic sectors, in order to combine a "demand-pull" effect with a "technological-push" evoked by the research programmes" (CEC 1985e:5-6).

The shared-cost formula was said to have proven to be the most satisfactory support mechanism and will form the basis of most pre-competitive research programmes in the future. The Commission suggested that in order to stimulate the valorisation of pre-commercial research and prolong the support up to the phase of prototype development, it would be conceivable that it would support innovating SMEs by means of non-budgetary methods, for instance through innovation loans or participation in risk-capital. This is the first time the Commission expressed the will and suggested possibilities to support innovation in firms beyond the pre-competitive stage.

'To a European Technological Community' expressed a firm plea for research on behalf of industrial competitiveness. The 'bottom-up' approach, was put forward as a mechanism to select priority programmes. "In the selection of the programmes, the advice of the participants who invest their capital in these

programmes and whose readiness to act, are the key to ultimate industrial success, must be decisive" (CEC, 1985e:14, translation PB).

A subsequent Commission communication on the implementation of the 'European Technological Community', based on a consensus in the European Council and Parliament on this matter, urged for an aggressive strategy, a qualitative leap and an accelerated increase of efforts to achieve this (CEC, 1985f:2). The immediate task for the Commission was to settle the second Framework programme. A chapter on the business environment, established a weakness in innovation of European firms, mainly due to failure to transfer research into commercial success. The answer to this problem of exploitation should be found in the completion of the internal market and harmonisation of segmented markets (CEC, 1985f:11). The problem of exploitation should thus be solved by the market and not by direct Community intervention.

With the 'Single European Act', first agreed to in December 1985 and ratified in 1987, technology policy finally received its legitimate base with the confirmation of the 'European Technological Community'. In a new article (Article 130f) of the Single European Act it is officially stated that:

"(t)he Community's aim shall be to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level." (SEA, Article 130f)

In 1986 the Commission proposed the second Framework Programme for 1987-1991 (CEC, 1986c/e). The general lines of the previous Framework Programme were still valid but some new themes were added. After agreement by the Council it was allocated a budget of 5,4 billion ECU, an increase of 1.65 billion ECU compared to the first Framework Programme. It had eight themes to categorize its programmes. Not all themes were equally important. The proportion in the total budget, as shown in table 3.3 is a good indication of the weight of the themes.

Table 3.3: *Funding of the Second Framework Programme (1987-1991)*



Aston University

Content has been removed due to copyright restrictions

Source: CEC-DGXIII, 1990d.

This Framework Programme (1987- 1991) comprised 32 specific programmes. Compared to the previous policies, most striking was the shift from energy related policies to those aimed at stimulating information technology. This shift had already started in the early 1980s as we have seen above. On first appearance it looks as if the pre-eminently mission oriented projects in the energy sector had lost their weight. However in absolute figures spending on nuclear energy increased (1051 MECU as against 940 MECU in the first Framework), whereas spending on energy saving and alternative energy decreased (122 MECU as against 830 MECU in the first Framework).

Most of the second FWP's budget was appropriated to programmes on the second theme: information technology and telecommunications. On information technology alone, 1600 MECU was spent on one programme: ESPRIT II, aimed to develop basic technologies for the European IT industry. The other major programme was RACE (Research and Development in Advanced Communications Technologies for Europe) with a budget of 550

MECU. Within the third theme, modernization of industrial sectors, the aim was to modernize the traditional industrial sectors, by improving research in general key technologies mainly in car manufacturing, tool, metal and chemical industry and transportation. Demonstration projects also started in the steel and textile industry. The specific programmes in this theme were BRITE/Euram, research for raw materials and the Bureau Communautaire de Référence (BCR) for measurements and testing. The fourth theme was mainly research for bio-technology, with programmes as BRIDGE (Biotechnology Research Programme for Innovation and Development Growth in Europe), ECLAIR (European Collaborative Linkage of Agriculture & Industry through Research) and FLAIR (Food Linked Agro-Industrial Research Programme).

The shift in research areas clearly indicates a more industrial orientation in the priority areas. We have to look at the programme level to see whether this is implemented according to the linear or more toward the integrative approach of innovation. The section on modernization of industries was aimed at the traditional industrial sectors such as textiles, building construction and motor industry (CEC, 1986c). Its funding had more than doubled compared to the first FWP. This points to a commitment to diffusion oriented support. Chapter 6 explores this for the case of BRITE/EURAM. It can be observed that it is premature to conclude that a shift had occurred from a predominantly mission-oriented policy towards a diffusion oriented policy, merely on the basis of the shift in focus from nuclear energy to information technologies. If we have a closer look at the policy towards information technology and in particular the ESPRIT programme we can still see important features of mission oriented policies: aimed at creating radical innovations from basic science in a small range of technology - the mega-chip being the most ambitious example -, a concentration of companies involved in the agenda setting and participation in the programme, and the large scale of the scheme. The companies involved in ESPRIT were the so called 'National Champions',

large electronics companies with a firm domestic base in one of the European countries and relying heavily on their traditional home market. ESPRIT started as the result of a series of Round Table discussions between the EC - in particular DG III: Industrial Policy - and the heads of Europe's leading electronics and IT companies: the 'Big Twelve' (Sharp, 1989:208). According to Sharp (1989) the Age of the National Champion, the 1960s and 1970s, has demised and changed into the Age of Collaboration in the 1980s. The collaborative activities changed the outlook of these National Champions beyond their own safe markets and towards international competition. The previous chapter already established the minor spread of the projects in terms of both industry and Member States. Over 80 % of the first round of contracts went to the twelve Round Table companies. The majority of projects involved participants from two to three Member States (Sharp, 1989:209). The original 'Big Twelve' clearly dominated the ESPRIT programme in the later years. Together they received 50 percent of all Community funding in the first phase of ESPRIT, and in 66 per cent of all ESPRIT projects at least one of them is participating (Roscam Abbing/Schakenraad, 1991:5).

Under full programme however this unbalanced participation of the few National Champions changed towards more widespread participation of firms and research institutions. A shift from fundamental pre-competitive research to more applied research, with better commercial prospects can be observed as the programme progresses (Den Hertog and Leyten, 1991). Sharp (1989) concludes that the features of the Esprit programme like its openness, has made it very successful in creating a better position for the European IT industry. She sees the role of ESPRIT as mainly a psychological one: as a channel for cooperation, as a mechanism for creating convergent expectations amongst top level decision takers about the future and thirdly as an important constituency pressing for the completion of the internal market. So the programmes have created a 'European' feeling and the awareness that they cannot succeed as National Champions any more. One can have doubts about the 'Eurocentrism' of the European business leaders. Perhaps it is only in the

minds of EC policy makers that Japanese and US companies are a mere threat and European companies potential collaborating partners. In reality the 'National Champions' are cooperating more and more with their Japanese and US competitors. The case of the takeover of the British computer company ICL by Japanese Fujitsu and the subsequent ejection out of the 'Round Table' group and ESPRIT is another illustration of the misconception that the European electronics industry can be kept 'truly European' (Financial Times 5/2/91).

A much less positive assessment of a programme like ESPRIT is given by Roobeek. She portrays EC technology policy and in particular the information technology programmes as "enormous subsidies to a handful of European champions" (Roobeek, 1990: 904).

In the proposal for this second Framework Programme the Commission stressed again the pre-competitive nature of the Community programmes. The choice of priority areas "combines a strategic conception of the "top-down" type with "bottom-up" implementation" (CEC, 1986c:3). Thus the Commission decides on the major strategic issues, and industry and researchers can influence the definition of projects. EUREKA is for the down-stream projects.

The more clear indication of a change in approach can be found in the outlook of the third Framework Programme that runs from 1990 to 1994. The overlap with the second Framework Programme is deliberately planned to avoid gaps in transition, given the long decision procedures which delay the launch of the new budgets. The third Framework Programme has an even stronger emphasise on information technology and telecommunication. At the turning point of both programmes, there are over 50 EC RTD specific programmes, and actions, most of them part of the Framework programme (CEC-DG XIII, 1990d).

Table 3.4 shows the distribution among themes and the funding amounts. A new priority area is 'Management of intellectual resources' which includes the

Human Capital Mobility programme, allowing researchers from less favoured regions to gain work experience in research centres of the industrial core of the EC. This programme received a budget of 488 MECU for 1992 to 1995. Environmental research is a new priority area however containing programmes that existed previously under the heading 'Quality of life' and marine sciences.

Table 3.4: The third Framework programme (1990-1994) and its funding in MECU, including additional funding in 1992



Aston University

Content has been removed due to copyright restrictions

Source: CEC, 1992c, and tech europe , august/september 1992.

In september 1992 these amounts were topped up to avoid a 'financial gap' caused by the delay in the approval of the fourth Framework Programme (tech europe, august/september 1992). There were less themes in this Framework Programme, but this was due the compression of headings rather than programmes being curtailed. Compared to the previous Framework Programme there was a sharp increase in the funds towards information technology and a decline of funds towards energy research, primarily at the

cost of nuclear fission. Funding for life sciences and bio-technology increased, mainly in favour of agricultural and agro-industrial research.

Summarising this period, with the legitimate basis following the Single European Act, EC competence in RTD was assured, however this did not lead to major increases in the budgets. The main change has been the continuation of the shift from energy research to information technologies. Training and mobility of researchers came up as new priority areas.

3.5 *Research after Maastricht*

A more far reaching integration in the European Community was to be triggered by the 'Maastricht Treaty' negotiated in 1991, published in 1992, and ratified by all Member States in 1993. The Maastricht Treaty has mainly a procedural significance for EC RTD policy. It has changed the decision making process, giving European Parliament a larger role and thus increasing the length of endorsement procedures. The new Treaty stipulates that the Framework Programme shall be adopted according to the co-decision procedure and specific programmes shall be adopted by a qualified majority procedure, subject to consultation with the European Parliament.

Psychologically when the Treaty was only just negotiated, it functioned as a trigger for new initiatives and reorganisations of Commission services. The departments responsible for RTD policies, DG XII and DG XIII were significantly restructured to coordinate management of the programmes.

However in the Member States sharp debates preceding the Maastricht Treaty put the subsidiarity concept high on the agenda. In particular the British fear for too much federalism, the negative result in the first Danish referendum, and the narrow victory of the 'yes' voters in France, made EC policy makers aware that extending its scope of power was reaching certain limits. This awareness is shown in the proposals and communications from the Commission. The Union Treaty (Maastricht) has made the subsidiarity

principle an absolute criterion for all Community action in article 3(b) (Andersen, 1992:160). This means that in the areas which do not fall within its exclusive jurisdiction, the Community shall take action only if the objectives of the proposed action can be better achieved by the Community than by the Member States acting separately, because of the scale or effects of the proposed action. Delors' interpretation of this principle applied to RTD policy means a return to 'mega-projects'. Delors stated that the next round of the Community's Framework Programme or research would be more focused on targeted projects in key technologies ¹⁰.

The subsequent problems in the ratification of the Treaty with referenda in Denmark and France showing a lack of enthusiasm for the European idea in those countries, has turned the Maastricht Treaty, into an obstacle for further developments in policies.

Despite these general legislative and political obstacles, the atmosphere in relation to RTD policy seems to be a very optimistic one, aimed at boosting Community activities. The basis of Community RTD policy in the Maastricht Treaty can be found in the new article 130f, paragraph 1:

"The Community shall have the objective of strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other Chapters of this Treaty." (CEC, 1992a:15)

Only the last part of the sentence is new compared to the phrasing in the Single Act of 1987. It means that research should have a supportive role towards other EC policy areas, like needs for society, rural developments and agricultural policies.

¹⁰ New Scientist 8/2/1992

The general atmosphere at the Commission to boost European RTD activities can be best illustrated by the proposals for a new budget for the fourth Framework Programme. In the main proposals of the Commission for the future EC budget, the so called 'Delors II package', total research funding is set to reach 6 % of the total EC budget by 1997, a doubling compared to the present budget. The Commission recommends a policy shift: the new key words are 'targeted large scale projects'. The projects involve key technologies in addition to existing basic research programmes. "As for what these key technologies are exactly, the Commissioner [Mr. Delors] cited projects in the electronic sector, industrial technologies with spin-offs for transport, and bio-technology as particular examples" (tech europe, May 1992). After the Edinburgh conference in December 1992, the proposals were slightly modified as the Council of Ministers demanded that the subsidiarity principle receives more significance. Moreover they called for a greater selectivity of RTD activities in order to increase their economic impact (European Council, 1992).

The strategic discussion paper "Research after Maastricht: An assessment. A strategy", a communication from the Commission, aims to confirm the increased momentum for RTD policy. 1992 is to be the pivot year for RTD policy, backed by the reinforcement of EC industrial policy and the decisive role of RTD for the competitiveness of European industry. The Community RTD efforts are considered insufficient compared to those of the USA and Japan, particularly RTD directly related to industry.

Although a comparatively low R&D expenditure is presented as one of the factors behind the lag of European industries, the document again draws the conclusion that:

"(...) the main problem for European enterprises is basically not the level of their RTD expenditure. It is rather their poor capacity to transform their RTD activities into inventions, and their inventions into market share and profit." (CEC, 1992a:14)

The lag is diagnosed as more a problem of strategy than of research: "(...) the problem is Europe's weakness in integrating R&TD and innovation in an overall strategy which both exploits and orientates them. (...) In other words, it is not R&T which directs the strategy and organization of a company, but rather the opposite" (CEC, 1992a:14). The vision in this document reveals a clear influence of the integrative approach of innovation. R&D expenditures are not seen as the solution to all problems.

This time the Commission partly blames its own RTD policy, and many points of criticism are mentioned: dispersion of funds, a lack of strategic choices for programmes and projects, rigidity of administrative procedures and the tendency for self-perpetuation of programmes. One could conclude that all this calls for policies that focus on promoting the downstream phases of technological trajectories, including diffusion. Indeed, the Commission finds that in the future:

"Research programmes with industrial aims, characterised by a 'technology push' approach, must take more account of market expectations and their priorities. A new approach to research and innovation based on the concept of a continual cyclical process rather than a linear scheme, must underlie all the Community activities. Objectives of Community programmes must be refined and concentrated around technological priorities." (CEC, 1992a:22)

This quote is an articulate illustration that the Commission aims at a policy shift from a linear toward a more integrated innovation model. The same document stresses 'disseminated innovation' as one of the positive aspects of EC RTD policy.

"Community actions have contributed strongly ensuring the penetration of new technologies into the tissue of different sectors of European industry. This is especially true for the programmes devoted to diffusing technologies. Two programmes have this characteristic: ESPRIT for information technology and BRITE/EURAM for industrial materials and technologies." (CEC 1992a:20)

However at the Research Council of April 29 1992, the document did not receive a very favourable welcome from Ministers. Most Member States were of the view that the Commission went too far in its desire to improve the competitiveness of companies and that Community policy had to limit itself to a large extent to fundamental research (*tech europe*, May 1992). The fact that Community RTD policy is decided on by Ministers of Research and not by Ministers of Industry contributes to the arduous transition from research policy to a wider innovation policy. It was partly the influence of then Commissioner Pandolfi, who favoured a shift towards industrial research. His successor Commissioner Ruberti, made a step back to pre-competitive research, much more in line with the Council of Research ministers (*tech europe*, May 1993).

The notion of concentrating RTD policy on 'targeted technologies', introduced in the Delors II package, finds support in the Member States. The UK CREST members, presented a paper to the national experts in the committee to suggest that the Community should target on 'high-priority' technologies. The first step would be to draft a list of generic technologies, with an impact on a number of industrial sectors. The background for the British initiative is the concern that industry, through a 'bottom-up' approach in the selection of priority technologies, could take advantage and use Community funds for national projects. If policy-makers decide before hand which generic technologies are considered most important this would create a reference to set priorities, according to the British view (*tech europe*, november 1992). Such an approach does resemble of the type of policy Ergas (1989) designated as severely 'mission-orientated' in which policy makers set the - narrow - agenda for the technological developments of the future. Yet, this depends on the organisation of the process of setting up such a priority list. If a wide range of experts from industry, research, and also users are involved, who take account of the possibilities for wide application of the generic technologies,

the narrow focus could be avoided. Decentralisation of agenda setting is one of the key elements of diffusion oriented policy, in Ergas' views.

In April 1993 a proposal for the fourth Framework Programme was presented to the Council with a budget of 13.1 billion ECUS, representing an increase of about 16 % between 1991 and 1994. The bulk of funding for R&D programmes, is earmarked for information technology and communications (36 %). Energy comes second with 23 % of the total budget (*tech europe*, May 1993). New themes are transport and socio-economic research. The decision making process of the FWP was the first to follow the so called co-decision procedure, which gives the European Parliament more influence in approving the Commission proposals. In case of the fourth FWP, Parliament's position, was in between that of the Commission, with a 13.1 billion ECU proposal and the position of the Council with a total budget of 12 billion ECUS. The final agreement was on a budget of 12.3 billion ECUS with an additional 700 million ECUS being kept as reserve. One point of disagreement between Commission, Council and Parliament concerned the 'Third Activity' on dissemination, the part of the FWP holding most diffusion oriented programmes. European Parliament asked for 380 MECUS, whereas the Council only allocated 300 MECUS, half the amount the Commission originally proposed. The compromise after reconciliation procedures was a budget of 330 MECU.

Four key themes run through this FWP: greater selectivity, greater integration of EC and national activities, synergy between research and training, and responsiveness or the ability to respond rapidly to scientific and technological developments (*I&T magazine*, summer 1994). For this last theme Delors had hoped to use the financial reserve, so the Commission could respond to acute industrial problems. In a policy note on the fourth Framework Programme, European research Commissioner Ruberti sketched the new strategy for RTD

policy, as discussed by the European Council in Maastricht and especially Edinburgh:

"In keeping with the Community's industrial policy strategy endorsed by the Council, based on ideas proposed by the Commission, research activities must focus on generic technologies with a multisectoral impact which reinforce the competitiveness of industry especially in key sectors and on themes of interest to society in general. The results must also be transferred rapidly to industry, especially to small and medium sized businesses and to the branches of the economy which will use them." (Tech Europe, April 1993)

Table 3.5: Commission proposal, Council position and final decision for breakdown of research funding of the fourth Framework



Aston University

Content has been removed due to copyright restrictions

Source: tech europe, July and August-September 1993, January, March, April and May 1994 and I&T magazine, CEC DG III and XIII, spring 1994.

The interpretation what the impact on diffusion of innovations will be is ambiguous. Firstly the focus on generic technologies with multi-sectoral impact is a choice that can be seen in favour of a more diffusion oriented policy. The larger number of sectors that could benefit from the results of the research projects, the higher the speed of diffusion and the wider the impact in the industrial fabric. On the other hand, the reference to key sectors and to the transfer of results to industry tends toward a dichotomy: on the one side we find sectors that create new technologies through research (for instance information technology) and on the other side there are industries that adopt these technologies. Thus there are suppliers and users of technologies. RTD policy will aim at supporting the suppliers' research and subsequently facilitate the transfer of the results to the potential users. This approach does not take into account the fact that diffusion is interlinked in the innovation process, for the suppliers as much as for the users of technologies. There seems to be no concern with the absorptive capacity of industry in such a polarized approach. In spite of the renewed competence in EC industrial policy, research has to remain strictly pre-competitive, according to the Council. Industrial research more close to the market will be conducted under the Eureka programme. It was mainly the UK that emphasised this issue in the Council debate (tech europe, may 1993).

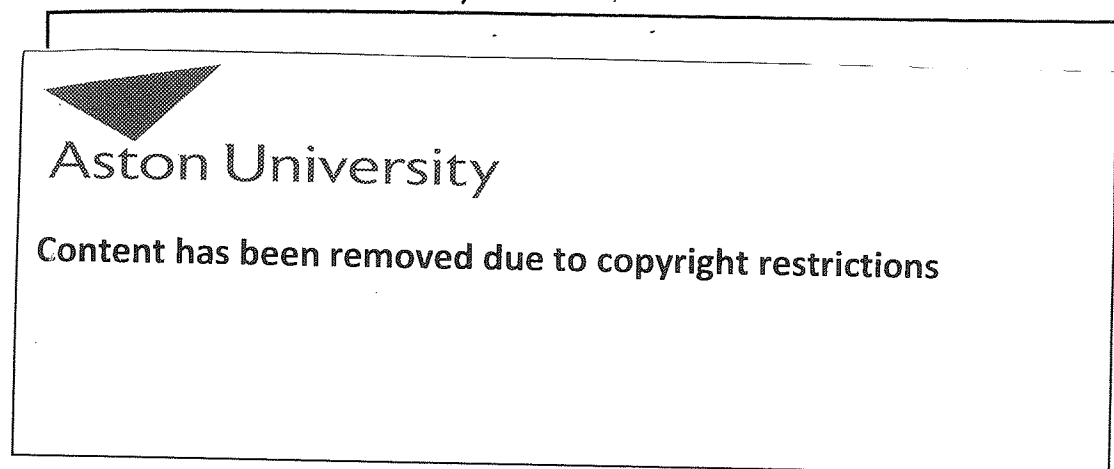
3.6 A decade of Framework Programmes: an overview

The budgets for RTD have increased enormously from the first to the fourth Framework Programme as we can see in figure 3.1.

Comparing the fourth FWP with the previous FWPs, the doubling of the budget is the most striking feature, an indication that the consensus on a larger EC role in RTD is taking shape. We have to note that some titles, which fell outside the previous FWPs are added in the fourth FWP. These

were the so called preparatory, accompanying and support activities or APAS in Commission jargon. The Sprint programme is an example of such a programme. The fourth FWP is thus the implementation of the wish to integrate all research activities, as expressed in the Maastricht Treaty.

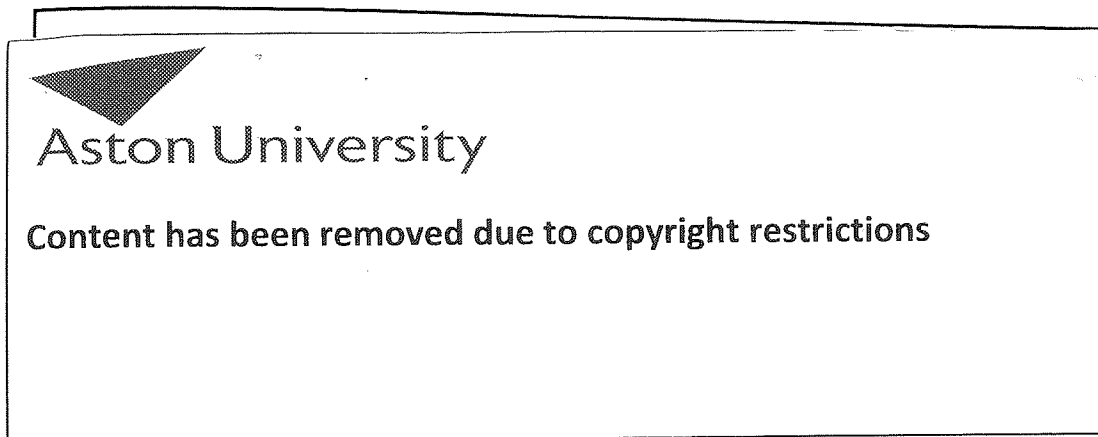
Figure 3.1: Budgets for the Framework Programmes in billion ECUS



Source: Compilation of CEC data.

The distribution of funds over themes demonstrate EC RTD policy priorities in the last decade. Figure 3.2 illustrates the shift in the share of funding for the main research areas of information technology, industrial technology, energy, biotechnology & technology for the agro-industry, technologies for the environment, and training and dissemination in the four Framework Programmes. The emphasis of R&D funding has been on strategic technologies, first defined as nuclear energy, soon to be overtaken by information technology.

Figure 3.2: The share of funds over six main research areas from 1984 - 1998



Source: compilation of CEC data (CEC 1985b, 1988a, 1992c).

We can see from figure 3.2 that energy -in particular nuclear energy - takes almost half of the budget in the years up to 1987. After the first Framework Programme this figure drops drastically. The increase in the fourth Framework Programme can be attributed to the theme of 'Technologies for cleaner and more efficient production and use of energy'. Nuclear fusion and fission, good for 25 % of the budget in the first Framework Programme, are proposed to receive only 8 - 10 % in the fourth. The most spectacular rise in the budget was in favour of information technology, in particular the ESPRIT Programme. However this area has seen a relative decrease in the last two FWPs. One of the reasons behind this is the aforementioned criticism, that IT policy was getting too close to an industrial policy on behalf of a small number of 'National Champions'.

The share in the budget for 'Industrial Technologies' has been quite stable over the years. Most of this is destined for the BRITE/EURAM programme, which will be discussed in chapter 6. The share of environmental programmes rises slightly whereas funding for 'life sciences' (bio-technology, bio-medicine and research for the agro-industry) shows a sharp increase at the start of the 1990s, confirming its recognition as one of the strategic technologies for the future.

Striking is that programmes under the heading training & dissemination show a slight decrease in the latest Framework programme, despite the numerous claims that greater weight shall be given to the exploitation of research results and training of researchers in the less favoured regions.

Looking at the developments in the last decade, we can see that the objectives have shifted from priority to a small number of 'strategic' technologies to RTD areas with a broader impact on the economy. The spread of funds to more technologies and stages in the innovation process, reduces the risk of large failures in the choice of projects. Furthermore a cross-sectoral spin-off from EC research is more likely. The EC has a strong tendency towards a mission oriented policy, but has shown in recent years efforts to complement this with a wider set of innovation targets and more diffusion oriented initiatives.

The broad trends described at the national level (see Rothwell/Dodgson, 1990; Rothwell/Zegveld, 1982), can also be found at Community level, but with a different chronology. In the first decades of EC policies there is a strong technology-push model underlying the programmes. There is no genuine EC technology policy yet, RTD policy is concentrated solely on energy research. Whereas in the seventies, in national policies the science-push model is gradually ousted by the emergence of innovation policies, with more attention to demand-side factors, industrial participation and SMEs, at EC level this shift only starts in the eighties. The national innovation policies

of the 1980s gradually emerged from industrial policies towards declining industries, that were common in most EC nations in the 1970s. From a 'defensive' industrial policy the priorities changed to an 'offensive' innovation policy. At Commission level a similar background of interventionist industrial policy was not present. As EC technology policy had its real take off in the beginning of the eighties, we can say that EC trends were lagging behind the national trends. But in the short life of EC RTD policies we can see that they have gone through a similar learning process that has taken place in more than three decades of national RTD policies. Catching up at these trends has sometimes placed them on the forefront of discussions in policy debates. At this moment of 'third generation' technology policies, more and more attention is being paid at both the demand-side of technology and the institutional context in which innovations take place. The question is if the Commission manages to make this change in the implementation of its policies.

3.7 EC diffusion policy and programmes

So far we have looked at the priority areas of RTD policy defined as broad themes and technological areas. Behind these themes lies a range of specific programmes with specific objectives towards industries, research areas, technologies or other innovation support functions. In the context of this study, the discussion of programmes is confined to those that are specifically aimed at or contribute to diffusion as defined in the first chapter.

In the aforementioned Maastricht Memorandum, a discussion paper by a team of innovation experts and policy makers, four options for an EC role in diffusion are brought forward:

- to encourage the diffusion of technologies across national borders through standards and educational programmes;

- to support regional cohesion, for example through technology transfer;
- to provide advice on the coordination of regional, national and EC innovation policies;
- to use procurement policies to transfer knowledge and skills (Soete, Arundel, 1993:86-88).

The list gives a very modest approach to the possible EC role. It also reveals a notion of diffusion as an additional action alongside the core RTD efforts in the Framework Programme and not as an integrated part of an overall innovation policy.

In Delors's 1993 White Paper on 'Growth, competitiveness and employment' again a explicit statement is made that:

"Emphasis is placed on **coordination** of RTD conducted by the Community and the Member States, focusing on key areas, simplifying procedures, in particular to facilitate the access of SMEs to RTD, and especially improving the **dissemination and application** of RTD results, notably by promoting standardization." (CEC, 1993a: 86)

The report calls for action to overcome the weakness of the European scientific and industrial base:

"First, steps must be taken to allow better **application of the results of the research** carried out in the Community, i.e. the establishment of **operational mechanisms** at national and European level for the transfer of technologies from university laboratories to companies, from one company to another and from the military to civil research sectors." (CEC, 1993a:8)

However we have seen in the discussion on the fourth Framework Programme that the Commission was allowed neither the 600 MECU it had asked for dissemination, nor a shift towards more market oriented collaboration projects.

In the previous paragraphs, evidence from several perspectives has shown a shift of approach in the support of innovation. However, EC's dominant support mechanism, the co-funding of collaborative and pre-competitive research projects appear to lack solid embedding in the innovation strategies of its participants. Delors' aforementioned White Paper of 1993 for the first time acknowledges this explicitly as one of the weaknesses of Europe's research base, i.e. insufficient account of RTD in business strategies and the lack of co-ordinated strategies between businesses, universities and the public authorities. However with this statement one does not refer to the Community's own RTD efforts. The case study in chapter 6 and material from this chapter confirm the gap between EC RTD projects and the innovation strategies of its participants. Several sources of information have pointed to their science rather than innovation character. The Commission has been made aware of this weakness and launched several activities to overcome this 'science push' dominance. DG XIII, Directorate D¹¹ is responsible for 'Dissemination and exploitation of R&T results, technology transfer and innovation'. The directorate is engaged in matters concerning patents and intellectual property, dissemination of scientific and technological knowledge, exploitation of Community RTD results and innovation and technology transfer. We have seen that these are all elements of diffusion oriented policy. For the dissemination of knowledge and R&D results, the Commission has set up databases such as the Community Research and Development Information Service (CORDIS) which is available on-line. Innovation and technology transfer is addressed by the SPRINT programme. The SPRINT programme was one of the first that is not concerned with funding research, rather supports innovation, for particularly SMEs, through building (technology transfer) networks, promoting best practice in management concepts, enhancing risk capital etcetera. It started as a programme to disseminate

¹¹ Before the reorganisation in 1993, this was directorate C.

available knowledge and technologies throughout the Community. Chapter 5 will discuss this programme in greater detail.

The other programme operated in this Directorate is Value (Valorisation and Utilisation for Europe), the Commission programme for dissemination and utilization of scientific and technological results. This programme was approved in 1989, with total funds of 38 MECU for 4 years (1989-1993). Value belongs to the second, third and fourth Framework Programme. In the first phase of the programme the main aim is to spread information on research, patents and on the results from EC funded collaboration projects¹². Another task was to support some participants of EC R&D projects towards a further application of their research. The support consists of assistance for market surveys, drawing-up of exploitation plans, and helping in the search of partners. The programme acts as an interface between industry and research. Thus the programme's role was to follow up the activities of the core RTD programmes falling under the FWP (CEC-DG XII, Value, undated information brochure). This corresponds exactly with the approach to diffusion we have seen in the traditional linear model: first one does research, one possibly invents something and then one starts to worry about how to exploit the research results. Presumably Value had to make up for the rising criticism on the lack of commercial results from Community supported collaboration projects (see for instance the ESPRIT Review Board, 1989 and CEC, 1988c BRITE evaluation). The programme set up a European wide network of *Value Relay Centres* which should act as an interface between industry and the scientific world, or the 'demand side' on the one hand, and the services of the Community or the 'offering side' on the other hand (Trousson, 1992). This action followed a Council meeting of Ministers responsible for the Internal Market in February 1992 which expressed the need to disseminate the findings of EC research findings (tech europe, april 1992). Value was allocated a

¹² Setting up CORDIS was funded by VALUE.

further 57 million to carry on their activities in the third Framework Programme.

A large diffusion oriented programme outside the scope of RTD policy is STRIDE (Science and Technology for Regional Innovation and Development in Europe) managed by DG XVI Regional Policy. The programme aims to improve the R&D infrastructure in the less advanced regions. Unlike the RTD programmes, STRIDE is not implemented directly by the Commission. The funds (400 million ECUS), financed from the Structural Funds, is allocated to the national governments, which subsequently decides how to re-allocate these to the regions.

Apart from these policies targeted to diffusion the numerous R&D collaboration programmes which undoubtedly have an impact on diffusion of technologies. ESPRIT and BRITE/EURAM are often referred in this context (CEC, 1992a, CEC-DG XIII, 1993c). We have to look at the actual performance of a programme to decide the degree in which a specific programme is diffusion oriented. Projects from the ESPRIT programme could certainly create spin-offs to industries specialising in the consolidation and maturity phase. Furthermore the agenda-setting of this programme has been determined by industries, a characteristic of diffusion oriented policy. However the fact that this was done by a very limited amount of large companies, defining the objectives towards their own needs, shows features of the centralised programme design, according to Ergas a key element of mission oriented policies.

We have seen that from the early 1990s in Commission communications, in particular in the strategic document 'Research After Maastricht' (CEC, 1992a) a clear plea for the integrative approach is made. However if we assess this on the basis of the type of support mechanisms and the priority lines of the last two Framework Programmes, this approach does not seem to be

implemented in terms of policy programmes. The CEC concept of actions committed to diffusion tends to follow the linear model: valorisation of the results of the essentially science-based collaborative research programmes. This dissemination of knowledge approach again tends to neglect the demand side and the institutional context of innovations. Chapter 5 will explore if this is also true in the case of SPRINT.

3.8 *Conclusions: a cautious incorporation of diffusion*

From the first Community efforts to support research to an innovation policy, as set out by the fourth Framework Programme, there are significant changes in the attitude to innovation and diffusion.

RTD policy up to the early 1980s was centred around a few 'big missions', mainly in nuclear energy and some relatively small research efforts that originated from the ECSC. The efforts were either very science oriented or related to industries in decline.

Around 1983-1984 a new type of RTD efforts was launched under threat of a lag with Europe's main competitors in what was considered strategic technologies and industries. These were again very 'mission oriented' in the sense that the programmes focused on a limited field of technology and a small number of firms - National Champions - producing these technologies. At the same time the collaborative research projects had to be of strictly pre-competitive nature. More applied research was supported within the EUREKA framework which was outside the EC competence.

Despite an early awareness that exploitation of R&D was a major factor explaining a lack of competitive edge of European industry, the interpretation of this problem towards the functioning of its own innovation programmes,

took long to get through to EC policy makers. However considering the entire period of Framework Programmes we can see some remarkable shifts:

- energy research which dominated the first FWP has to trade places with information technologies and telecommunication, but is still a major component of EC research;
- the mission oriented National Champion approach in the main RTD schemes, aimed to create state-of-the-art technologies, has given way to more applied research in these strategic fields, opening the way for a larger number and wider range of firms to participate;
- a range of new programmes with new RTD fields have been launched, such as human capital mobility and environmental research;
- more schemes that support the non-research aspects of innovation - training, dissemination, demonstration projects - have been set in operation.

The core RTD programmes have incorporated some diffusion elements in their support schemes. Firstly we have seen that the strict pre-competitiveness rule has been relaxed which makes, near market research and incremental innovations more likely to be supported. Criticism on the lack of commercial results from the RTD programmes has certainly played a role. The debate around the document 'Research after Maastricht' revealed that the Commission is willing to move even further towards 'near market' research, but the Council has put a limit to that move. Secondly some additional action is undertaken to assure dissemination of results of collaborative projects. These actions are mainly geared to support SMEs. Thirdly, sub-programmes are designed for SMEs to collaborate in collective research projects or in collaboration with larger firms.

However, despite the perceived shift in Commission statements, the dominant character of the programmes is still following the linear model in which research is the main parameter for boosting innovation, and in which many other strategic aspects of the innovation process are neglected. The RTD

efforts are aimed at the supply side of innovation and diffusion. The 'absorptive capacity' of the industrial sectors that have to implement and adopt technologies and the strategic aspects of innovation have not been addressed by EC RTD support.

Support mechanisms with an explicit mission in diffusion have gained weight in overall EC policy. This has culminated in the definition of a third activity in the fourth FWP carrying the title "Dissemination and exploitation of findings" which includes the VALUE and SPRINT programmes. In addition, actions for diffusion are taken outside the RTD policy context. Regional policies, backed by the Structural Funds, are changing their perspective towards more efforts in creating and improving the innovative capabilities and support structures in the less developed regions. However, the overview in figure 3.2 showed that the relative share of training and dissemination has decreased, mainly due to a slow growth in the budgets for training and mobility.

In chapter 1 we discussed how the concept of diffusion changes with the innovation model one aspires to. In the linear model, diffusion is the last stage in the innovation process in which ready made technologies have to be spread to its potential users. Diffusion here is a matter of spreading the right information to the right people. The dominant approach of policy-makers in the Commission is along these lines: the main purpose of diffusion is to disseminate the research results that come out of Commission programmes so that any potential user can benefit from the knowledge created with Community support. This approach is still very science push oriented, in the sense that even if research projects are conducted by firms, their pre-competitive character has moved them 'upstream' in the linear model. The results will not necessarily meet the demands of the firms in search for knowledge for new products or processes.

Diffusion in the integrated approach leaves policy makers with a much more complex mission involving many interlinked learning processes. This means

that policies have to be fine tuned to each aspect of Kline and Rosenberg's chain-linked model as was presented in chapter 1. The Commission has not shown the capability yet to make such an integrated effort. The only exception could be the SPRINT programme which does focus on the broad spectrum of barriers to innovation, mainly for SMEs. We will explore if it can meet this challenge in chapter 5.

To summarise the findings of this chapter, the commitment to diffusion is increasing, however as a complementary effort to the core collaborative research programmes, rather than an integrated element in overall RTD policy. In budget terms the exclusively diffusion oriented programmes are not very significant and isolated from Commission units that determine the RTD strategies in the long and medium term.

An increased diffusion effort at EC level raises another issue: how can such a policy cope with the diversity between the Community countries and regions, in terms of innovation capacity, knowledge infrastructures, industrial specialisation patterns, just to name a few? The next chapter will address this issue.

4. DIVERSITY AS A BARRIER TO DIFFUSION POLICY

4.1 *Introduction*

In the first chapter we argued that diffusion policy is highly dependent on socio-economic and institutional contexts. This poses a problem since the European Community is an entity with essentially different socio-economic and institutional contexts, which is reflected by highly different economic performances of the European countries and regions. The capability to create and diffuse innovations is one of the factors behind this. The diversity in innovation capability between areas can be explained by economic factors (i.e. industrial structure, type of firms, sectoral specialisation, market structure etcetera), of research and technology related factors (i.e. R&D intensity of firms, R&D infrastructure and its relation with firms, government R&D spending etcetera), institutional factors (i.e. innovation support systems, government support for innovation, market regulations, education system, etcetera), human resources (i.e. managerial capacity, skill of labour force, labour market) and many cultural and behavioral factors. Furthermore the factors should not be considered as static, but are engaged in dynamic learning processes of the actors involved. There is not only a diversity in assets but also in competencies and learning processes (Cohendet et al., 1992, Lundvall, 1992). "Therefore, technological trajectories are not only specific by industrial sectors, but also by their geographic and institutional location" (Llerena, 1992:6).

Innovation and diffusion capability depends on all these different and interrelated factors, including many non-technological ones. This makes it impossible to pass an unambiguous judgement on the innovation capacities of each region or country. Even though no country is homogeneous in its context, in this chapter we will try to distinguish patterns from studies and surveys that

have mapped and analyzed innovation capabilities of countries, regions and localities, using different methodologies and different determinants. The subject of research in this chapter is thus *geographical* difference in innovation and diffusion capabilities. One problem is that studies choose different levels of aggregation in their research objects: some look at indicators to compare the national level of performance, others aim to compare for instance the R&D performance of a nation's firms. The main level of comparison will be the national level. The European Community is essentially a community of nations and comparing diversity relies mainly on data and documentation at the national level. Furthermore in most European countries the design of innovation and research policies is made at the national level, even if in some countries like for instance Germany the implementation is at the regional level. In the last decade technology oriented regional development programmes have intensified (Rothwell/Dodgson, 1989). On some subjects interesting material is available for a Community wide comparison of the innovation capabilities of regions. In those cases this material is included.

Once we have given a picture of patterns of diversity, we can ask the question: "How does EC policy cope with this diversity in its policies to promote innovation and transnational diffusion?" Is the diversity an obstacle or an asset for innovation? This relates to a more general problem the EC faces namely the ability to combine the objective of external competitiveness (mainly regarding the US and Japan) with the objective of internal cohesion or socio-economic integration of the European people and regions. Is it even possible to design diffusion policies at EC level, given the diversity of systems of innovation?

Many models and studies based on different indicators are designed to describe the diversity between the Member States and regions. This chapter will present a review of these studies to see if we can distinguish common patterns for the countries, and in some cases regions of the European

Community. The question is to what extent diversity forms a barrier for a Community wide diffusion policy? In the traditional linear model, innovation support concentrated on facilitating R&D either through government funded research or subsidies to private organisations. Policy in the integrated model requires a co-ordination and fine tuning of policies in a much broader context. The institutional context, consisting of for instance support agencies and collaborative networks, is much closer involved in the policy implementation. Ergas (1986) mentions the importance of decentralised agenda setting as a feature of diffusion oriented policy. Is the EC policy capable of this type of fine tuning, given the highly diverse character of the institutional contexts in its Member States?

We shall look at the three most important perspectives to diversity in innovation capability: i.e. the R&D related, the economic and the institutional perspective. Finally we will discuss models that combine all or several of these perspectives to explain diversity.

4.2 *Diversity, cohesion and diffusion: defining the problem*

"In fact rarely does a technology not vary at least in its usage from one place to another. This diversity of technologies poses the problem of European coherence with respect to the diffusion of these technologies" (Llerena, 1992:5)¹³. As discussed in the introduction, the European Community is a collection of countries, regions and localities each with their own specificities. In the process of integration the Community has to find a balance between sustaining - cultural - diversity on the one hand, and converging into a Single European Market on the other hand. This integration process is moving

¹³ In the original language the citation is: "En effet, rares sont les techniques dont au moins l'usage ne varie pas d'un lieu à l'autre. Cette diversité des technologies pose le problème de la cohérence européenne en matière de diffusion de ces techniques" (Llerena, 1992:5).

towards the accomplishment of social and economic cohesion. It is the Single European Act that played a key role in orienting all Community policies, including technology policy, towards the improvement of economic and social cohesion (Caballero/Catinat, 1992:198). With the entrance of Spain and Portugal in the EC in 1986, the problem of a divergence between EC countries in terms of technological capability and R&D infrastructure in particular became more apparent. "Indeed, European technology policy could no longer be solely based on RTD programmes for high-tech industries as this would no longer be neither politically acceptable nor economically consistent" (Caballero Sanz/Catinat, 1992).

The Single European Act particularly expressed the need for Community pressure for a more integrated, competitive and cohesive Community in Article 130a of the Act:

"In order to promote its overall harmonious development, the Community shall develop and pursue its actions leading to the strengthening of its economic and social cohesion. In particular the Community shall aim at reducing disparities between the various regions and the backwardness of the less-favoured regions."

This guiding principle applies to all Community policies, and means that RTD policies should contribute to the decrease of regional disparities in technological capabilities. It emphasises the importance of the geographical dimension of RTD programmes, which seem up to now, not to have given this principle great priority. The objective of cohesion was brought into the guidelines to set up a new, second Framework Programme of Technological Research and Development. The intention was to speed up the Community's integration by stating that the immediate objective was to create a scientific and technological Community (Shoults, 1991:7). Shoults' conclusion is however that cohesion was never given a prominent role in EC RTD policies:

"While the Parliament and the [Economic and Social] Committee perceive the RTD role as capable of making significant contribution to cohesion,

the Commission proposals and the adopted RTD policy reveal, in general terms, a perception that the RTD policy role is to be limited." (Shoults, 1991:3)

Cohesion is a long term objective and RTD policy will come more and more under pressure to contribute towards it. Diffusion oriented programmes can make a strong contribution to cohesion. Less advanced countries often have an economic structure dominated by traditional industries, with predominantly small and medium sized enterprises. This type of firms is more dependent on incremental changes and adaptations of process technologies that have been launched to the market in other industrial areas. These are not the type of innovations which are expected to result from the core RTD programmes within the Framework Programme. The Maastricht Memorandum understands the role of diffusion policies to support cohesion as a deepening of general policies to support diffusion across national borders. "This can be achieved through a more active role on the part of the EC in developing infrastructure and technology transfer programmes that are designed to meet the specific needs of peripheral regions" (Soete/Arundel, 1993:87). They refer to the SPRINT programme as an example. This programme will be discussed in chapter 5. This suggests to imply that the other type of EC RTD programmes, mainly R&D collaboration schemes, could not contribute to the principle of cohesion. We will explore this question in the case of the BRITE/EURAM programme in Chapter 6.

Comparative studies have shown that the rates of diffusion of particular technologies among countries, also those within the EC, vary enormously (Nabseth/Ray 1974; Ray, 1984, 1989; Edquist/ Jacobsson, 1988). Often these differences are interpreted in a negative manner, as a sign of lagging behind of some countries compared to others. As we have seen in chapter 1, it is too simplifying to blame potential adopters for non adopting due to resistance to innovation. The reasons for non-adopting can be very rational. It can also

mean that different countries, with different industrial sectors need different technologies.

This, however, does not imply that diversity of development trajectories between the countries does not matter. The current composition of a nation's production matters since it moulds the future growth and technological development. "A nation's current competitive success and failures in international trade will affect the areas in which technical skills will be accumulated, innovation undertaken, and economies of scale reaped" (Zysman, 1990:188). The institutional structure in which industry is embedded, help shape the pattern of economic development. Innovation policy is an important element of government intervention that directly aims at (re)shaping this pattern. The question raised here is whether the European Community as a trans-national government body, can design and implement diffusion policies, which require to be fine-tuned to national and regional circumstances. Michael Dietrich raised a similar question regarding to the industrial policy of the EC (Dietrich, 1991). His argument is that restructuring industry, necessary for innovation is not only a question of restructuring markets, as is aimed with 'The Single European Market'. Industrial policy should recognise that restructuring industry also depends heavily on strategic management and networking of firms. Policies that seek to improve these activities need to be proactive and very much bottom up. This is in strong contrast with the very centralised top-down approach in the Community policies for industry. Since the traditions and culture of strategic management, and networking strategy differ very much from country to country.

"... a policy must contain European and nationally based elements that mesh into the disparate managerial traditions involved."
(Dietrich, 1991:435)

Recently innovation policy has regained interest as an instrument for competing national strategies (Porter, 1990). Despite the process of

globalisation, or even exactly because of globalisation, national differences become competitive advantages and thus national governments attempt to emphasise its domestic models of innovation. "Models of technology development abroad become at once domestic alternatives and international threats" (Zysman, 1990:185). Competition between nations is usually examined from the viewpoint of the three trade blocks Japan, US and Europe (Ohmae, 1985). However it is still present between the EC countries as well.

"The argument that technology evolves in nationally rooted trajectories and the 'new' trade theory case that in oligopolistic markets governments acting strategically can create advantage in specific sectors are considered to suggest the possibility of competing national routes of industrial development." (Zysman:1990:186-187)

Large enterprises can more and more source for national advantages in different countries and spread their activities accordingly. They will thus become increasingly 'foot-loose' in their country of origin. This trend is only incited by developments in information and communication technologies. This raises the question whether the diversity between the EC countries is an asset, i.e. a combination of different innovation models, or a threat to EC integration, i.e. a source of internal rivalry. This reflects intensified international discussions on the question who is appropriating the benefits from national (or EC) research and development efforts in a globalizing world.

"Competitive advantage is created and sustained through a highly localized process. Differences in national economic structures, values, cultures, institutions, and histories contribute profoundly to competitive success. (...) While globalization of competition might appear to make the nation less important, instead it seems to make it more so. With fewer impediments to trade to shelter uncompetitive domestic firms and industries, the home nation takes on growing significance because it is the source of the skills and technology that underpin competitive advantage." (Porter, 1990:19)

"More specifically, the process of far-reaching European integration may run into serious problems if it does not take into account the complex

interaction between institutions and economic structure in promoting innovation at the national level." (Lundvall, 1992:4)

Is the political power of the European Community strong enough to overcome these nationally rooted differences and even conflicts of interest? The diversity in innovation competencies creates a conflict in RTD policy making, due to opposing national interests. Technology policy aims at improving the competitiveness of European industry and simultaneously at improving internal cohesion. Before cohesion was a political factor of importance, improving competitiveness meant enhancing the position of Europe's high technology industries. "... it is a fact that most of these high-tech activities are located in the technologically more advanced countries. As a natural result of this pattern in the geographical deployment of high-tech activities, those countries and regions are the main beneficiaries of European RTD programmes designed to maintain Europe's position in the world's technological frontier" (Cabellero Sanz/Catinat, 1992). Choosing for the option of supporting only leading edge technology is thus in flat contradiction with the cohesion objective. Several analysts have pointed to the unequal distribution of EC RTD funds through the collaborative programmes (Roobeek, 1991, Roscam Abbing/Schakenraad, 1990). The Commission is very hesitant to provide systematic data on the geographical distribution of RTD funds. This is understandable since it wants to avoid political pressure to engage in a 'juste retour' debate, in which Member States ask for a geographical allocation of budgets. RTD policy is one of the few policy areas in which the 'just retour' principle does not formally apply. The Commission wants to base selection of projects on technological and scientific merits and strategic choices.

Roscam Abbing and Schakenraad (1990) point to the policy dilemma of direct support to firms for the Commission.

"(...) on the one hand it feels that European industry has to be supported in the development of strategic technologies, on the other hand, in order

to do so effectively, the synergy of a large technological potential is needed. Promotion of combined technological research thus stimulates a process of industrial concentration, which may hinder new firms to enter the field and creates a fertile environment for oligopolistic behaviour." (Roscam Abbing/Schakenraad, 1990:2)

This brings us to the economic rationale of improving the innovation capabilities of a wide range of industrial sectors in all Community regions: to avoid that Europe has leading edge firms in the strategic technologies, but a lack of large industrial markets, consisting of innovative firms that can buy and apply these strategic technologies.

With the gaining of weight of the cohesion objective, closing the gap between the less advanced and the advanced countries on technological capabilities became a more important, though not dominant aspect of EC RTD policy.

4.3 *Perspectives of diversity*

The introduction of this chapter described various perspectives of looking at diversity of 'national systems of innovations'¹⁴. In this paragraph we will look at several determinants of performance on innovation and diffusion. The last section discusses models that have attempted to combine these determinants.

Within the limits of the present study on EC RTD policy, this chapter can not offer a comprehensive overview of the literature and studies on diversity in innovation and diffusion capabilities. The aim is to highlight the complexity and interrelatedness of the many factors that determine the differences in these capabilities and thus to point out the obstacles for a Community wide policy to facilitate diffusion.

¹⁴ See for a recent overview and discussion of this concept Lundvall (1992).

4.3.1 The R&D related perspective

Since the Second World War up to now, science and research have played a key role in innovation policy. We have discussed in chapter 1 the theoretical and policy making background of this inclination. It is therefore not surprising that comparative studies on innovation have concentrated on the R&D perspective. In this perspective the link between a country's science, research and development assets and its innovative and economic performance is the key factor of analysis. These assets consist of government funded science, industrial research and development efforts, both private and (semi-)public and other private R&D activities.

Traditional models of innovation regard the national expenditures on R&D in countries as the most important indicators for the degree of innovativeness of countries. It is one of the most classic indicators of national performance. In the linear model of innovation, supply side inputs would automatically lead to new products and processes as if the innovation process were to be a pipeline, as we already discussed in chapter 1. The integrative model makes a comparison between countries even more difficult: the inputs into the innovation process are much more complex and include many non-technological, even intangible, factors. The problem with the R&D indicator is that it is only one of the inputs in the process of innovation, among many others (see Lundvall, 1992:6). In addition, R&D inputs do not reveal differences in R&D outputs.

This does not mean that data on R&D inputs have lost all their analytical significance. The size of R&D expenditure reflects the size of the R&D infrastructure, the importance of firms engaged in R&D and government efforts to enhance R&D.

In comparative analyses of countries, the OECD indicators on science and technology are the most commonly used empirical data, which depend, for a

large part, on R&D expenditure figures. These figures still provide a starting point to judge a nation's R&D efforts of industry and government.

If we first look at Gross Domestic expenditure on R&D in figure 4.1, we see large discrepancies between EC countries:

Figure 4.1: Gross domestic expenditure on R&D as a percentage of GDP



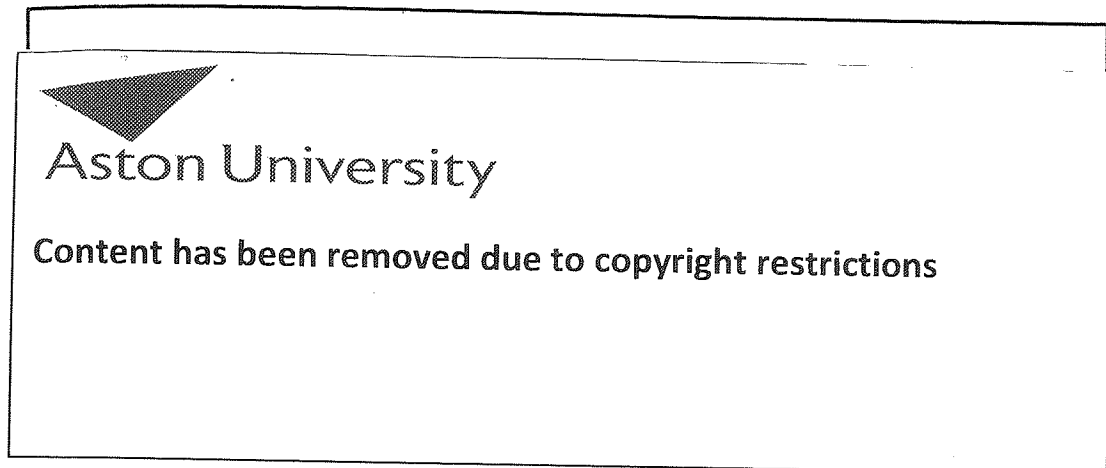
Aston University

Content has been removed due to copyright restrictions

Source: OECD, Main Science and Technology Indicators, 1992.

These figures are for both civil and military R&D, government and industry expenditure. Germany, France, UK and the Netherlands have a gross expenditure of more than 2 % of their GDP. Greece, Ireland, Portugal and Spain on the other hand, have an expenditure of less than 1 % of their GDP. The distribution of the finance of R&D expenditures between industry and government, illustrates how much a country depends on government spending in the performance of R&D. Figure 4.2 shows this distribution.

Figure 4.2: Sources of R&D expenditures

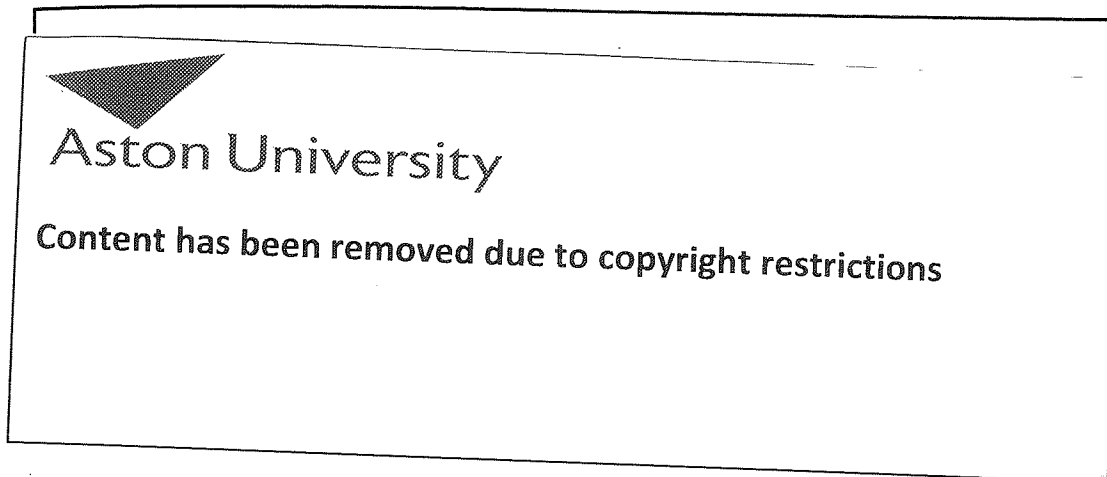


Source: OECD, Main Science and Technology Indicators, 1992.

We can see that in Belgium, Germany, Ireland and Netherlands more than 50 % of R&D expenditure is financed by industry. For the latter two countries we should make the comment that a large part of these expenditures are dominated by a few multinational companies. Freeman states that this is the case in most OECD countries which have a "... skew distribution of R&D with a heavy concentration in the largest firms. In the larger countries 100 firms usually account for about two-thirds or more of total industrial R&D. There is some national variation but usually *industrial* R&D accounts for between 60 and 70 % of total R&D (GERD), ..." (Freeman, 1992:179). In the small countries the distribution is even more distorted. Statistics from Eurostat show a more detailed picture of government R&D appropriations related to GDP and to government budget. Figure 4.3 shows that Denmark, the Netherlands,

Spain, UK, Germany and particularly France spend more than 2 % of their national budgets on R&D.

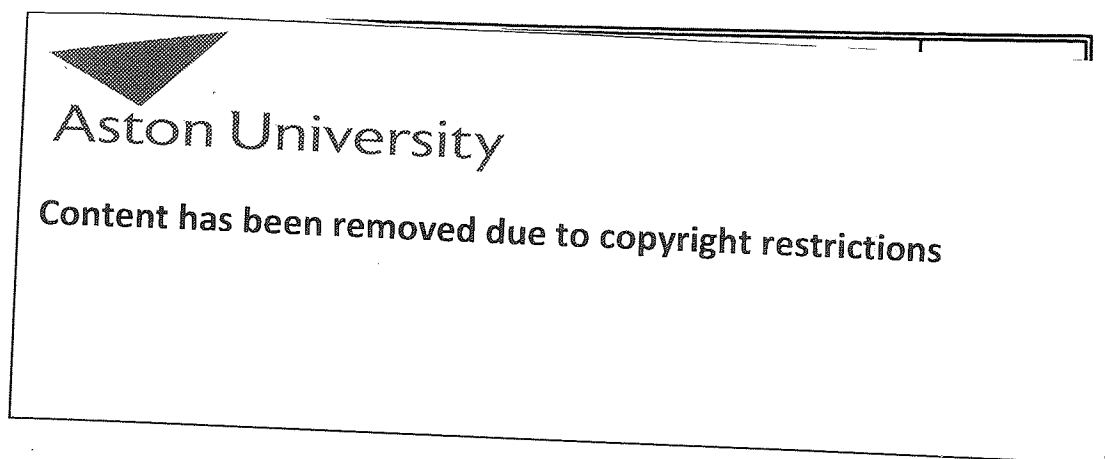
Figure 4.3: Government R&D in the European Community



Source: Eurostat, 1991.

The direction of R&D funding, in terms of industrial sectors, differs from country to country as well. In table 4.1 we see the relative distribution of total government financing for several chapters of NABS (Nomenclature for the Analysis and Comparison of Science Programmes and Budgets):

Table 4.1: R&D Financing by chapters of NABS in % of total financing



Source: Eurostat, 1991, page 66.

We see that most countries spend between 12 and 19 % of government sources towards research in industrial production and technology, with the exception of Ireland and the Netherlands which spend more and the UK that spends considerably less on industry related R&D. The last country has an extremely high percentage of government spending on defence related R&D, only joined by France. It is apparent that countries with a predominantly agrarian structure as Greece, Ireland and Portugal spend relatively much on agricultural research.

These statistics offer a static picture of the situation around 1990. We can also look at the trends in expenditure over a longer period. In figure 4.4 we see how expenditure has changed between 1985 and 1989 and the expected change between 1989 and 1990.

Figure 4.4: *Change in the expenditures between 1985 and 1990*



Aston University

Content has been removed due to copyright restrictions


Source: Eurostat, 1991.

In the five years period between 1985-89, the countries in the lowest grouping appear to attempt to make up for long periods of underspending in R&D. R&D financing has risen 26 % in Portugal, 25 % in Greece and over 20 % in Spain. Only Ireland has not shown a large increase in R&D expenditures, however the expected change for the year 1990 is over 13,9 %. Some more favoured countries, Denmark and Italy have shown large increases as well.

As said above, figures on R&D expenditures do not unambiguously relate to the outcome of these efforts. An indicator of R&D output, often used to analyse innovation capability is the number of patents originating from a country (Pavitt/Patel, 1988; Archibugi/Pianta, 1992). Empirical data can be found in "The Panorama of European Industry" where the competitive position in new technologies is measured by the number of inventions of a certain

quality applied for patent in at least two countries (CEC-DG III, 1993:85-98). If we want to make international comparisons, this method is statistically more reliable than any statistics on new products or process innovations. A problem with patent statistics is that they do not show the many incremental innovations that make up for a large part of the innovation process, especially in more traditional industries. Another problem is that patents are only important for a small number of industries (Nelson, 1988:316). If we look at the position of EC countries compared with each other we see the following distribution:

Table 4.2: Inventions by country/region of origin in all fields of technology

	1975-1979	1980-1984	1985-1989
 Aston University Content has been removed due to copyright restrictions			

EC		
----	--	--

Source: Compilation of data from CEC-DG III, Panorama of EC industry, 1993:86.

Germany has a clear lead position with nearly half of all patented inventions. "This is a far greater share than Germany's share of EC GDP (roughly one

quarter) or than its share of industrial production in the EC. This confirms the pronounced specialisation of German industry on R&D or know how intensive industries" (CEC DG III, 1993:87). Germany is followed at considerable distance by the UK and France with an almost similar position of around 17 %. Apart from them only Italy and the Netherlands have significant scores of inventions.

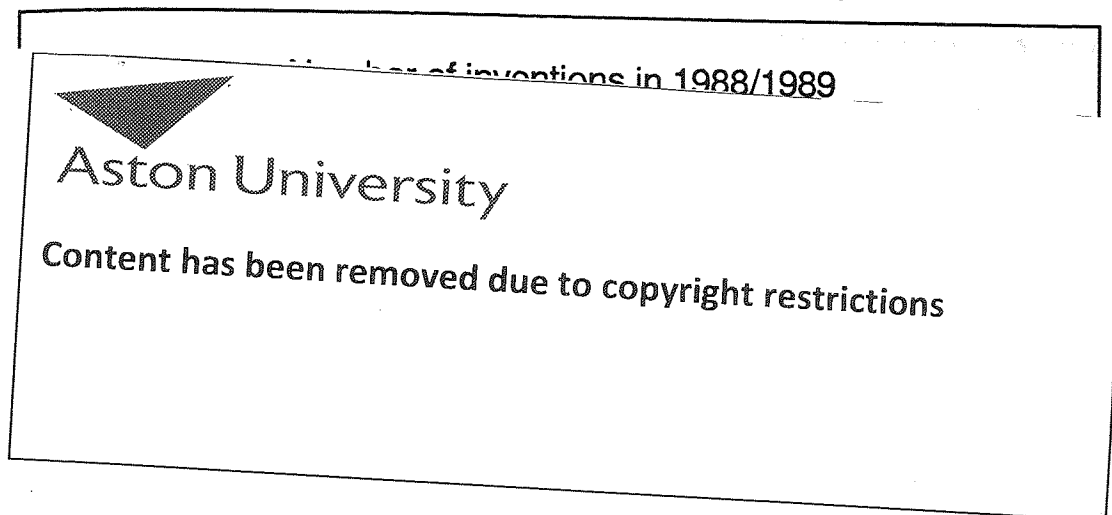
R&D performed in private companies is an even more important indicator of innovative capabilities than public spending on this area. We have seen expenditure data in figures 4.1 to 4.3. These input data do not reveal the efficiency of R&D efforts in terms of their results. The number of patents acquired by companies is one possible output measure. The following figure (4.5) shows the most ingenious companies from Europe, in terms of patented innovations. Again we see a dominant position of German firms, followed at distance by French, British and Dutch firms.

An analyses of patent data by Patel and Pavitt (1991) shows a large concentration of patenting activities in the EC: 96 percent of the EC total is from the top five countries, Germany, United Kingdom, France, Netherlands and Italy.

If we sum up all these different R&D related indicators into a general pattern we can conclude that we can roughly distinguish three groups of countries:

- a top group with relatively high spending on R&D from both governments and industry (above 2 % GDP): Germany, France, UK and the Netherlands. In terms of output Germany is far ahead followed at certain distance by the UK and France.
- A middle group that has a good to medium performance on some of the indicators, Denmark, Belgium/Luxembourg and Italy.
- A bottom group that has a low ranking on several indicators: Spain, Portugal, Greece.

Figure 4.5: Most ingenious firms in Europe by patented innovations



4.3.2 The industrial structure perspective

The industrial structure of a country or region is one of the most decisive factors for differences in innovation and diffusion capability. At the same time it is the factor most complicated to analyse. Diversity plays a large role in the evolutionary economics and especially in theories of economic change (see for an overview of the significance of diversity Cohendet et al., 1992:10-26).

Macro-economic figures are relevant in comparing countries in terms of economic growth, national income, distribution of wealth, however they do not tell us much about diversity in innovation and diffusion capabilities. We are looking for more specific indicators. The industrial structure of countries has several interrelated elements that affect innovation capabilities: sectoral specialisation patterns, composition, size and regulation of (industrial and

consumer) markets, distribution of large and small companies, inter-firm relationships and internal organisation of firms. For example each industrial sector has different degrees of R&D intensity, thus the specialisation pattern affects R&D expenditures. In the words of Kline and Rosenberg (1986:280), the state of knowledge in the relevant science and technologies varies from industry to industry and from firm to firm. Large companies tend to have more resources and larger efforts to perform in-house R&D than SMEs. In some countries specific industries have a long tradition of collective or collaborative research and innovation activities. And large and sophisticated national markets in high-technology products and components have a stimulating effect on the national producers of these goods. Thus a mix of factors at different levels of aggregation determine a country's innovation capabilities. Analysts usually focus on one or two elements, since the complexity of the causal relations make a comprehensive study a insurmountable task. For instance do the R&D performances of firms determine the R&D capabilities in that country or the other way around?

In addition many studies are limited to one or two countries, comprehensive comparative analyses of these elements are few.

In the explanation of the difference in performance between countries, the historically developed patterns of sectoral specialisation form a key factor. Keith Pavitt's (1984) classic article *Sectoral patterns of technological change: Towards a taxonomy and a theory* was one of the first to distinguish similarities and differences in sectoral patterns of technical change. Industrial sectors are compared in terms of the sectoral sources of technologies used in a sector, the institutional sources and nature of technologies produced in a sector and finally the characteristics of innovating firms. A central feature was to see whether the sector of production, of use, and the principle activity of the firm were the same (Pavitt, 1984:346). This results in a taxonomy with three basic category of firms with different technological trajectories: supplier dominated, production intensive and science based. These different trajectories can in turn

be explained by sectoral differences in three characteristics: sources of technology, users' needs and means of appropriating benefits from the innovations (ibid.:353). Supplier dominated firms can be found in traditional industries, are generally small and have weak in-house R&D and engineering capabilities. Most innovations come from suppliers of equipment and materials. Sectors with these types of firms are highly dependent on diffusion to gain access to innovations produced elsewhere. Since they are mainly competing on the basis of costs, it is expected that process innovations are mostly used. Production intensive firms are described as large scale firms which make use of an increasing division of labour and simplification of production tasks, resulting from an increased size of market. Lowering of the production costs, enabled by the substitution of labour for machines, is an important motivation for innovation. Closely related to these type of firms are the specialised equipment suppliers. These, relatively small and specialised firms are an important source of process innovations in the production intensive sectors. The last category consists of science-based firms, where the main sources of technology are the R&D activities of firms in the sectors, based on the rapid development of the underlying sciences in the universities and elsewhere. Pavitt refers to the firms in the chemical and electronic/electrical sectors. The pervasiveness of the range of knowledge these firms have to master, and the possibilities for different applications they encompass have made these firms grow rapidly and at the same time made it difficult for firms from other sectors to enter them.

This last type of firms and sectors is often related to strategic sectors, which can alter the technological paradigms. This role has been particularly ascribed to firms in the electronics sector, engaged with information technology. The strategic role of electronic components such as semi-conductors, has given rise to concern whether Europe has sufficient strong firms in these sectors, that can compete with the Japanese and US firms. As we have seen in the previous chapter this was the most important impetus for the launch of EC technology policy.

This approach discloses patterns between sectors, it is however one step further to translate this into a spatial viewpoint in terms of geographical specialisation patterns. Pavitt's empirical research is based on data from the UK and although it gives a good characterisation at the analytical level, it does not allow international comparison of country specialisation. A later article by Patel and Pavitt does make the international comparison of technological performance of sectors and firms per country. They state that:

"There has been uneven development among sectors, in part as a consequence of the micro-electronics revolution. There has also been uneven developments among countries. (...) This is because the international diffusion of technology is neither automatic nor easy. In addition to - and just as important as - the transfer of machines and blueprints, it requires the conscious accumulation of complex technological skills through experience and analysis." (Patel, Pavitt, 1991:37)

They discuss the shortcomings of analysis to explain the differences in technological capabilities, one of the reasons being the "very real difficulty in measuring and comparing technological accumulation across firms, sectors and countries." Using both R&D and patent statistics they attempt to give a plausible picture of technological activities in sector and countries. One conclusion of this study relating to Europe is an uneven development: across countries with the increasing strength of the Federal Republic of Germany and decline of the United Kingdom and across sectors with increasing strength in chemicals and decline in electronics. The subject of comparison has focused on the relative performance of the US, Japan and Europe, not so much between the European countries. Patel and Pavitt have found that large countries and regions are technologically more self-contained than smaller ones, in the sense that foreign technological activities, by foreign firms, are relatively less important. In addition, the strengths and weaknesses of each region or country are in general reflected in the number of nationally based large firms that have a position in the top 20 of shares in American patenting (Patel/Pavitt, 1991:53-54).

A more comprehensive approach to divergence in performances of sectors and countries is Porter's (1990). He developed a series of tools to reveal specialisation patterns of sectors in each nation, based on the use of export statistics. The main problem is not why do some countries perform better than others, but why do some countries perform better in some industries than in other industries? A country can be competitive in industries and sectors that operate in the country, but no country is successful in all sectors, neither competitive as an entire nation. Porter found that economic theories so far are insufficient to explain this phenomenon, so a theory is needed to explain competitiveness of particular sectors of a nation. Although countries are the object of Porter's analyses, the book is 'aggressively industry specific', as he phrases himself. Porter introduces two models in his book. The first is the 'cluster chart' of each country under investigation. Using export statistics and other material on the international activities of industries, one can identify the more competitive industries of a country. A sector, defined at a very low level of aggregation, is considered competitive if it has a share in international export markets, higher than the national average in all sectors.

Porter divides the sectors in sixteen clusters named after the end-use of the products and services they provide. This offers a very fast and relatively simple method to see what patterns of specialisation a country has developed. The clusters of sectors can indicate networks of sectors, possibly reinforcing each other to upgrade their products or production processes, for instance by sharing distribution channels, technological experience or research facilities. Porter has among his country studies only Germany, the UK and Italy as EC Member States. A similar study has been made of the Netherlands using Porter's method (Jacobs, Boekholt, Zegveld, 1990). The conclusions of these studies is that competitiveness in each specific sector is the result of a complex and interrelated set of determinants in each country. These determinants are not static, they can be upgraded or lose their significance to a sector, for instance due to technological changes. Porter has systemized these determinants in four categories: factor conditions (ranging from physical to

human resources), firm strategy, structure and rivalry, demand conditions (size and sophistication of the markets) and finally related and supporting industries (clusters and networks of firms). These determinants are different for each industry and in each country. In Porter's model innovation capability is an indirect factor effecting the upgrading of determinants of competitiveness, and includes both improvements in technology as better methods or ways of doing things (Porter, 1990:45). Porter's concept of innovation tends to a rather 'romanticised' picture of the creative entrepreneur who endeavours in innovation despite the obstacles: ... innovation is the result of unusual effort. (...) The strategy is the personal crusade of an individual or group" (ibid.: 49). The Porter model offers tools to map out the strengths and weaknesses of national economies and their industrial sectors. Its contribution has been to systemize the complexity of the factors involved explaining the performance of industries and countries, stretching out much wider than indicators of R&D input and outputs. We must bear in mind that competitiveness and innovation capabilities are related but not identical. Sectors can be competitive on the basis of their low production costs, such as the textile industry in South East Asia, or on their capability to integrate changing user needs in their designs, such as the textile industry in Italy.

The industrial perspective has shown that:

- innovation capabilities vary from sector to sector;
- not all sectors have an equal impact on technological diffusion to other industrial sectors;
- sectoral specialisation patterns differ from country to country;
- the performance in terms of competitiveness in sectors and in particular technologically important sectors differ from country to country;
- the causal relations between these three are not clearcut.

Looking at available studies in this field there appears to be a lack of empirical studies analysing the relation between innovation capabilities and the industrial structure on a Community wide basis.

4.3.3 The institutional perspective

The importance of institutions in innovation has been widely recognised in innovation literature with a renewed interest in the last decade (Hodgson, 1988, Nelson, 1988, Porter, 1990, Freeman, 1992). Nelson states that one possible function of the institutional design is to get an appropriate balance of the private and public aspects of technology: "... enough private incentive to spur innovation, and enough publicness to facilitate wide use" (Nelson, 1988:314). This would suggest that governments have a major role to play in the diffusion of technology. On the other hand government is the main source of funds for fundamental research (Freeman, 1992:180), one of the origins of radical innovations. Porter's book (1990) was one of the contributions that made the national institutional context reappear on the agenda's of analysts and policy-makers. The problem in the context of this thesis is the question whether the institutional context in the Member States is appropriate to facilitate the diffusion of technology and the absorptive capacity of firms. We have seen in chapter 1, discussing Brown's infrastructure perspective, that the supply side of diffusion, the diffusion agencies, play an important role in the spatial patterns of diffusion. Ergas states that the efforts in the diffusion oriented countries have primarily involved strengthening institutional mechanisms for technology transfer, such as the vocational training system, the system of industrial standardisation and the network of co-operative research (Ergas, 1986:5).

Every national state has developed its unique style of regulating industry and technological innovation. A large part of the innovation support system in a

country is organised by or stimulated through government innovation policy. In many countries a wide array of support mechanisms is developing that reveals a public/private mix of actors. Alongside direct innovation related institutions, there are many others that shape the innovation capabilities of countries, such as the presence of risk bearing financial institutions.

On the one hand we can distinguish a diversity in the set of regulatory - legal, fiscal, competition policy, and so on - mechanisms that shape business in general. On the other hand we can see a diverse pattern of innovation support infrastructures that play an active role in innovation and diffusion. This paragraph focuses on the institutional aspects related to diffusion, notwithstanding that it is difficult to draw a boundary between innovation in general and diffusion.

In literature the following institutional elements are specifically mentioned in relation to diffusion:

- collective R&D organisations. Examples are the German Arbeitsgemeinschaft Industrieller Forschungsvereinigungen (AIF) (see Ergas 1986) or the collective services in the Italian textile districts in Emilia Romana. These and other types of active networking in firms often occur in industries in their consolidation or maturity phases.
- Innovation support centres and technology transfer agencies, both public and private. Examples are the Agence National de Valorisation de la Recherche (ANVAR) organised in regional centres in France, and the Innovation Centres in the Netherlands.
- The education and in particular the vocational training system (see Ergas (1986), Porter (1990), Patel/Pavitt (1991)).
- Specific services such as patent assistance bureaux and standardisation offices.

In every country the mix between private and public agencies is different. In Germany for instance, like in no other EC country, many support activities are carried out by institutes that have been set up by trade associations. The firms

decide what research activities are undertaken. In France on the other hand the diffusion support infrastructure is set up and financed by central and regional governments. In addition, it is set up very much in the linear approach model: the technology transfer infrastructure is focused on disseminating the research results that emerge from the large number of government funded laboratories. Their main concern is finding industrial partners for these laboratories (Chesnais, 1993). The comparison of the German and French examples, shows that the existence of technology transfer infrastructures as such, does not reveal their diffusion orientation.

Comprehensive comparative studies that compare innovation policy styles and the character of innovation support mechanisms are few. Most of them compare two or three countries on the basis of a narrowly defined (policy) subject. There is particularly a gap in empirical studies that compare diffusion oriented infrastructures and mechanisms in the EC.

From the institutional perspective the big differences are not only to be found between the more or less favoured countries within the EC. Even between the 'big three' the models are decisively different. The most obvious divide is that on the basis of the level of direct government intervention in industrial technological change. For Europe France is the example of far reaching direct government regulation in innovation and technology, the UK the archetype of low government involvement (see for example Rothwell and Dodgson, 1990; Guy, 1991). In these typologies innovation policies are also examined as to how they are embedded in a more general industrial policy.

Ergas (1986) developed a typology of national policies that is related to their orientation towards the technology trajectory, as we briefly discussed in the first chapter. The central concern of his paper is to see what the impact is of countries' differences in innovation policy on innovation performance (Ergas, 1986:13). As aforementioned he distinguishes three groups of countries: those in which innovation policy is 'mission-oriented', those in which policies are

'diffusion-oriented' and finally Japan as a group on its own, combining both previous categories. We have discussed the characteristics of these typologies in chapter 1. The Community countries discussed in his publication are the three core countries France, Germany and UK.

In France, a truly mission-oriented country, the change in industrial technology is pursued through major state initiated programmes. "The technical élite which is more or less integral part of the State apparatus, is the essential repository of technological skills and plays the key role in accumulating and transferring know-how" (Ergas,1986:7). It has been relatively successful due to "... the great political legitimacy, operating autonomy, and technical expertise of its end-user agencies, combined with the strong incentives for success built into the highly personalized nature of power and careers in the French public administration" (Ergas,1989:18). Its weaknesses are the small numbers of actors involved in the major government projects and the occurrence of goal displacement of successful organisations. The UK has been remarkably less successful in its mission oriented policies. The system of public administration avoids any flexibility and openness implementation of the major projects. They are very much defense related, with few spin-offs to other industrial areas. Other sectors have little benefit from the high R&D expenditures. "Mission oriented research has tended to yield few direct benefits while possibly crowding out a substantial share of commercial R&D" (Ergas,1986:26).

Germany is a truly diffusion oriented country where trade associations play a major role in the agenda-setting for technology policy and assessing the requirements for industry in the face of technological developments. It is also a "... paradigmatic case of deepening. Skills and resources appear to be highly industry-specific and their development follows paths largely charted by the industries themselves" (Ergas, 1986:7). Therefor Germany's industry concentrates on incremental innovations and its industrial structure favours existing industries rather than emergence of new ones. The comprehensive system of education and vocational training, and strong cooperative R&D are the main assets that sustain Germany's strong position in existing industries.

The government's technology policy is very well geared to this industrial structure with a decentralised process of implementation and emphasis on technology transfer.

The typology that Ergas sketched in the mid 1980s is not as valid at this moment as it was then. RTD policy orientation has changed character in all three countries especially in the mission oriented countries France and UK.

"Despite some historical differences in approach to the formulation and implementation of public RTD policies and in the role of the state in influencing the direction of industrial technological change, there has, nevertheless, during the 1980's been some convergence amongst major European nations in both the nature and focus of RTD policies." (Rothwell and Dodgson:1990:12)

This can be found in more emphasis on SMEs¹⁵, collaborative pre-competitive research in information technology and technology transfer oriented regional development policies. Particularly in France more emphasis is placed on decentralised (regional) innovation support, although the science-led and centrally governed innovation policy is still a dominant feature. Institutions as ANVAR and CRITT were established on a regional base to promote innovation, particularly that of SMEs. The first is an integrated institution that provides grants for R&D, feasibility studies and market research, gives consultancy on innovation, search for research partners, and counselling of technology transfers etcetera. The CRITT (Centre Régional d' Innovation et de Transfert Technologique) has a regional development origin with the goal to support the technological development of SMEs, set up collaboration with research centres and contribute in human resources management. We must note that their budgets are very small compared to the core research oriented funds. Ergas' views are however still very effective in distinguishing different

¹⁵ Rothwell and Dodgson see an increased support to New Technology Based Firms as growing focus of innovation policies. These policies although growing in number in the late eighties have not shown to have gained an important position within overall RTD policies. See also Fahrenkrog, Boekholt, 1993.

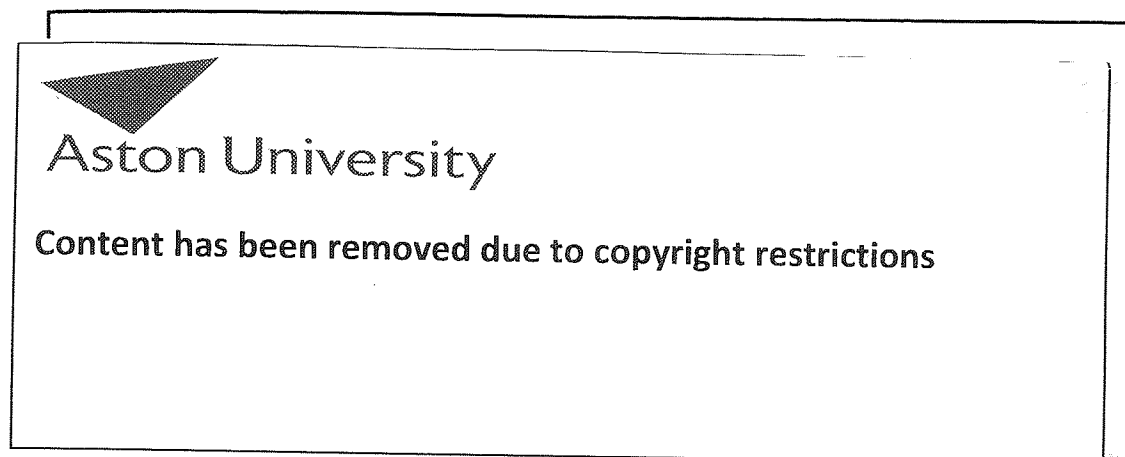
tendencies for the choice of certain policy programmes at national and Community level.

What empirical evidence can be brought forward to demonstrate diversity at the institutional level? The problem is that differences are mainly qualitative thus difficult to quantify. Statistics are available on funding of universities but these should be used with great care because the basic national statistics are compiled in a very different manner. And again, this only reveals some indication of research input, not of innovation capability. Since there are hardly any Community wide comparative studies available, we have to rely on studies compare a few national case studies. France, UK and Germany are over-represented in these studies, which makes a comparison between the 'favoured' and 'less favoured' countries more difficult.

Since technology transfer agencies are an essential element of diffusion mechanisms a possible Community wide indicator of the strength of this infrastructure is the distribution of membership of TII, the European Association for the Transfer of Technologies, Innovation and Industrial Information. This organisation, celebrating its tenth anniversary in 1994, is widely known among innovation support organisations. We can make a distribution of its membership not only geographically but also by type of organisation. Of course we have to look at these figures with some caution. There can be various reasons why membership of some types of organisations is not well spread. An example are the German industrial research centres organised by trade associations which are not represented in TII, probably because they have a wider mission than technology transfer. Another distortion of these figures is caused by large decentralised organisations, that are only registered as a member through their headquarters. Finally, the membership fees are quite high which will discourage smaller organisations. The largest share of members are - private - consultants in technology transfer (32 %), followed by industry-research liaison services (19 %), regional and local government organisations (10 %) science parks (9 %) and chambers of

commerce (6 %). Figure 4.6 shows the distribution of members over the member countries.

Figure 4.6: Members of TII per country



Striking is that Germany, which counts as a model diffusion oriented country, with an extended infrastructure for technology transfer and diffusion, has a relatively small number of members. Private consultants and research-industry liaison organisations each form almost 40 % of the German members. On the other hand both the UK and France have a large number of members. In the UK a third of these members are private consultants and another third industry-research liaison offices. Other type of members are regional governments (of which many from the non English regions, Scotland and Wales) and technopoles. From France most members are also private consultants (36 %), but the second largest group (almost 25 %) are chambers

of commerce (TII, 1993). This illustrates the diversity of the organisations active in (transnational) technology transfer, even between the 'Big Three'.

In recent years the awareness of the importance of networking for innovation purposes is emerging (Porter, 1990, Camagni, 1991, Grabher, 1993). The rising costs for R&D, shorter technology life-cycles, and increased specialisation of firms into core-business, asks for collaboration with other sources of innovation. "... almost every significant innovation has involved inputs from a wide variety of different scientific and technical sources, as well as from users. A good external network is therefor vital for innovative success, including of course, access to university research, as well as other institutions" (Freeman, 1992:185). The proximity of firms to centres of excellence is thus an significant element of innovation capability. Especially for SMEs strategic partnering is essential to form coalitions of firms to combine specialised assets (Teece, 1986). Those firms which are located in the peripheral parts of the Community will have a disadvantage compared to those that have these centres within their own region. Public policy support is increasing throughout the Community to support the networking of clusters of firms (Fahrenkrog/Boekholt, 1993). Again the 'network culture' in a country or region is an important indicator, but difficult to quantify for comparative purposes.

4.3.4 Combining perspectives

Analysts of innovation have sought to systemise the characteristics of a nation's innovation capabilities by introducing the concept 'national systems of innovation' (Nelson, 1988, Lundvall, 1992). Lundvall (1992) suggests that the most relevant performance indicators of national systems of innovation should reflect the efficiency and effectiveness in producing, diffusing and exploiting economically useful knowledge. He also states that the choice of

performance criteria and the respective weights to be assigned to them are fundamentally normative. Unfortunately, despite the promising analytical value of this concept for comparison of nations, empirical studies so far have been confined to separate national studies. A systematic comparative analyses appears to be an arduous undertaking.

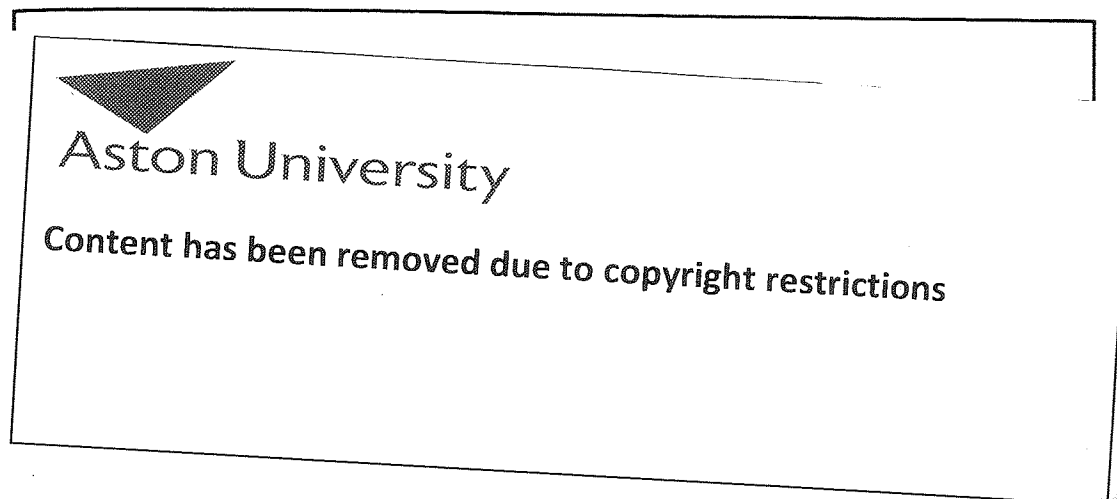
We have seen that various indicators for the innovation performance are used in analytical and empirical research. These indicators are highly diverse in character, in methodology of measurement, level of aggregation and time span.

Unfortunately few comparative studies manage to combine indicators to find patterns of diversity in the countries and regions of the EC in terms of innovation capability. The sheer amount of possible interrelated determinants of innovation, and the specificity of national, regional and local combinations make this an almost impossible task to fulfil. The Latapses study of local systems of innovation claims that: "... a generic criterion for measuring the performance of local systems of innovation does not exist; however it is possible to define diversified modes of efficiency between them" (Charbit et al., 1991:8). Most studies concentrate on specific indicators and case studies in the geographical sense. Studies that do combine indicators often look at innovation capability as one of the indicators for the competitiveness of nations or regions.

A comprehensive comparative study, using a wide range of indicators is conducted by IMD and World Economic Forum and, since 1980, published yearly in the "World Competitiveness Report". The competitiveness of 37 countries is assessed and compared on the basis of eight parameters. One of the eight factors is *Science and Technology*, composed of the indicators R&D Expenditure, R&D Personnel, Intellectual Property Generation and

Technology Management¹⁶. The ranking of the 22 most advanced market economies on *Science and Technology*, evaluating scientific and technological capacity together with success of basic and applied research, was as follows¹⁷:

Figure 4.7: IMD ranking on science and technology



Striking is the high ranking for Denmark and Ireland and the low ranking for the UK. For Denmark this high position is mainly due to a very good score on Technology Management¹⁸, in which it is world second behind Japan.

¹⁶ The other seven factors are Domestic Economic Strength, Internationalisation, Government, Finance, Infrastructure, Management and People.

¹⁷ Only the EC countries, the USA and Japan are taken from the IMD rankings. The ranking of other non-EC European countries (for instance Switzerland, Sweden, Norway) have been not included in these figures.

¹⁸ This indicator is based on figures and assessments of R&D in key industries, future R&D spending, production technologies, technology strategies and financial constraints.

Ireland owes its relatively high ranking on the factors R&D expenditure¹⁹ in particular a high business R&D expenditure, which we already saw in figure 4.2. The UK has a good score on R&D personnel and intellectual property generation, but a very low ranking on technology management and R&D expenditure. The ranking of EC countries, including those of Japan and US on these indicators are shown in the following figures.

Figure 4.8 a: Ranking on R&D expenditure by country



Aston University

Content has been removed due to copyright restrictions

¹⁹ This factor is composed by figures and assessments of total R&D expenditure, business R&D expenditure, funding of R&D and research cooperation.

Figure 4.8 b: Ranking on R&D personnel by country



Figure 4.8 c: Ranking on intellectual property generation

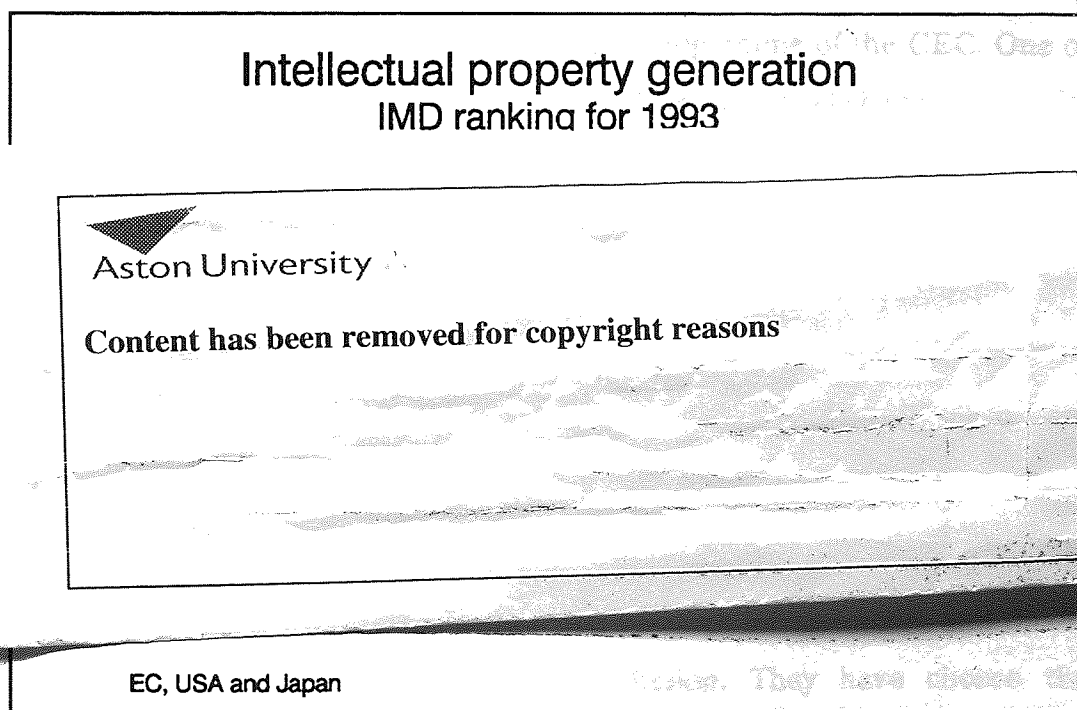


Figure 4.8 d: Ranking on technology management



Aston University

Content has been removed due to copyright restrictions

A major attempt to combine several indicators to compare European regions is made within several studies within the framework of the FAST (Forecasting and Assessment in Science and Technology) Programme of the CEC. One of these studies looked at the regional impact of technological change and social and economic cohesion (CADMOS, 1991). These efforts lead to a model in which regions are positioned according to their accessibility and receptivity to innovations. Accessibility represents all potentials and limitations to the physical possibility of getting access to an idea or investment in a region. Receptivity being the ability of taking into consideration an innovative idea or investment in a region. The model is based on the NEI regional database containing 29 indicators and 142 regions. The indicators are combined in the five categories economic development and specialization, agglomeration economies, labour market, innovation and research infrastructure and finally international orientation and cultural cohesion. They have chosen the following indicators related to innovation and research infrastructure:

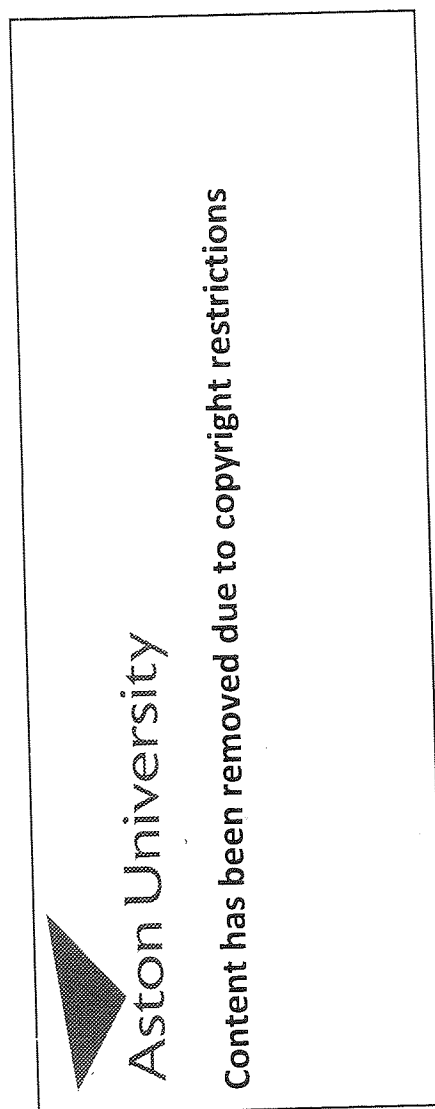
- product and/or process innovations of companies: in both stronger and weaker regions the majority of firms implemented some form of innovation in the eighties;
- share of business R&D expenditures in GDP: the availability of large scale firm R&D facilities has a more indirect effect, as it facilitates technology transfer in the region. Looking at the percentage of GDP spent for R&D expenditures per region we get a very uneven picture. "At Community level three quarters of total R&D expenditure (private and public funds together) was concentrated in Germany, France and UK in 1989 (OECD 1990b). Highly uneven distributions also exist within Member States" (CADMOS, 1991:55).
- Share of high tech in industrial employment: lagging regions employ lower shares of their labour force in R&D and modern technologically advanced and research intensive industries tend to cluster around a few major cities. "Also R&D facilities like universities and specialised research institutes are fairly concentrated in the more developed, urbanised regions in the Community." High-tech industry is strongly concentrated in German regions. Within the other countries spatial concentrations can be observed in economic core regions or in so-called 'new growth' areas. There is also a lack of high-tech activity in the objective II regions, the (former) traditional industrial regions (CADMOS, 1991:55-56).
- A classification of the technological infrastructure.
- Scientific output 1977 - 1986: A survey has shown that research output measured by publications, is far less in the lagging regions. Ireland and Northern Ireland are an exception.
- Islands of innovation in selected sectors: In the Archipelago - Europe studies, also made within the FAST framework, various centres or islands of innovation have been inventoried and they confirmed that innovation is concentrated in only a small number of regions and locations (CADMOS, 1991:58).

- Participation in EC R&D programmes: Metropolitan areas and regions like Brabant in Belgium, Ireland, Pais Vasco in Spain do very well in participation in the R&D programmes. Most of the regions which hardly seem to benefit from European R&D-programmes are located in Southern Europe (especially Greece and Portugal) and rural areas in Northern Europe.

The selection of these indicators was dependent on the availability of data and surveys on this subject. On the basis of the comparison of all these indicators (with help of multicriteria-analysis), the conclusion is drawn in this FAST study that the regions have different positions with respect to basic conditions relevant to science and technology, which offer some better access to innovation than others. An overall picture was made of the relative positioning of the regions with respect to the accessibility and receptivity to innovation. This leads to the following maps of the European Community:

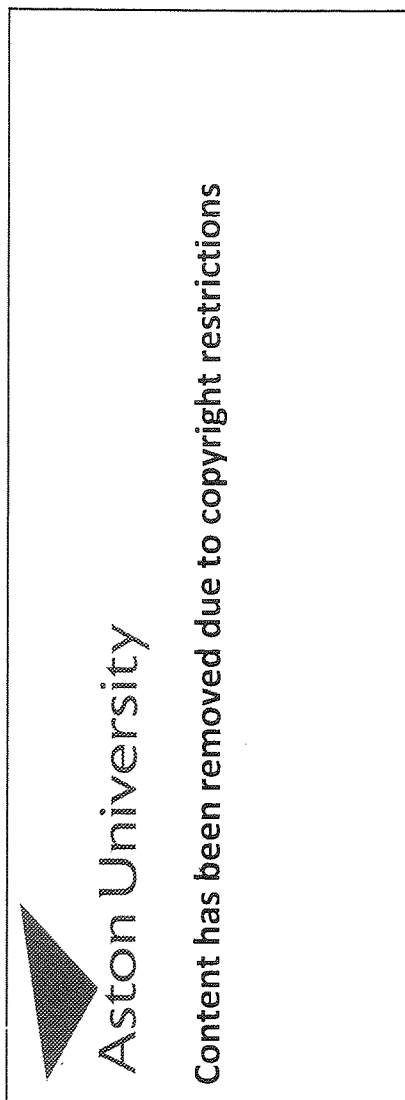


Figure 4.9: Accessibility to innovative ideas and investments



Source: NEI, in: CADMOS, 1991.

Figure 4.10: Receptivity to innovative ideas and investments



Source: NEI, in: CADMOS, 1991.

We can see that especially in terms of accessibility to innovative ideas and investments, the disparities between the regions of Europe are high. There seems to be an innovative band stretching from South East Britain, over the Netherlands and Belgium, towards the western regions of Germany, to the Mediterranean coast of France and ending in Catalonia in Spain. This band of innovative localities has been referred to as the 'banana shaped structure' after a study for DATAR (Brunet et al., 1989), which studied the success factors of European cities.

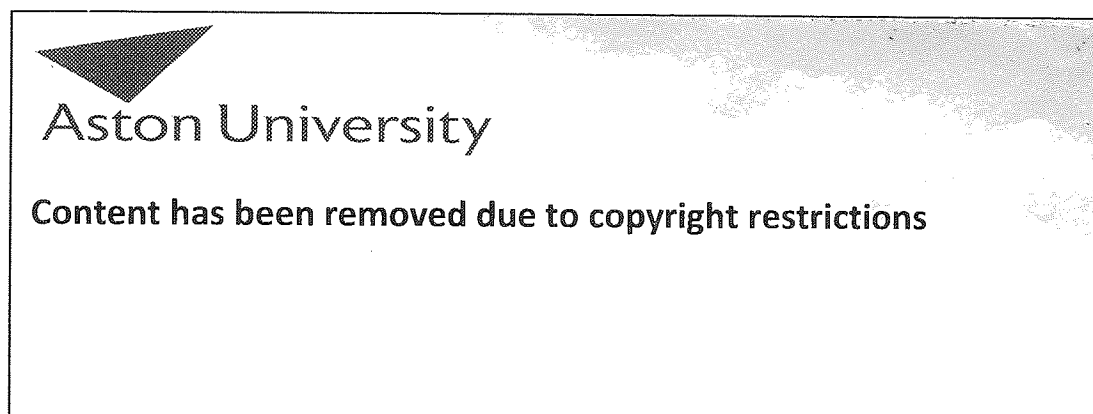
The scores of regions on both the factors for accessibility and receptivity in the CADMOS study are summarised in table 4.3.

The number behind the countries are the number of regions with a ranking in that box. The numbers in brackets are the total number of regions in that country. Each country has its own type of division in regions, so the absolute numbers are not comparable. In some countries the most innovative activities are concentrated in a small geographical area, in others the spread is more even. Some of the striking results of the study are:

- A third of the German regions score high on both accessibility and receptivity factors.
- The 22 French regions score badly: only 3 of them (Ile de France, Rhône-Alpes and Provence-Alpes-Côtes d'Azur) have high scores, 9 are in the medium range and 10 have medium and low scores. This shows the concentration of French innovation related performances in the Paris area and in the south east. A similar pattern is found in the UK, where only the South East performs well, almost half the regions are in the medium range and the same number have a medium-low performance.

Table 4.3: *Accessibility and receptivity to innovative ideas and investments, number of regions per country*

	high	medium	low
--	------	--------	-----



		Belgium 1 (9)
		Denmark 1 (3)

Source: Compilation of NEI study in CADMOS

- The smaller industrialised countries Netherlands, Belgium, Luxembourg and Denmark have very dissimilar scores: the Netherlands performs very well with 9 out of 12 regions in the high or medium range and only a quarter of regions in the medium-low box. Belgium has clearer a divide between high-medium regions and the medium-low ones. The last ones are mainly the regions in the east of the country specialised in agriculture and

forestry. The divide between the agrarian and industrial regions is also apparent in the case of Denmark.

- Ireland is judged to have a medium receptivity but a low accessibility to innovative ideas and investments. Their geographic isolation partly explains the low accessibility.
- Italy and Spain have large numbers of regions in the medium-low and low ranges of the score, with only a few in the highest category. In Italy half the regions, and in Spain three quarters are in the medium-low range. In Italy this reflects the North-South divide, in Spain the existence of a few islands of innovation (Madrid, Catalonia and the Basque Provinces).
- All Greek regions but one have a low score on both parameters and in Portugal only Lisbon has a moderate score, the other regions are classified in the lowest box.

The distinction between accessibility and receptivity has relevance for policy measures to improve the regional or national performance. Accessibility can be improved by establishing new socio-economic structures or infrastructure, thus supply side policies. Receptivity can be improved by instruments that increase the awareness and ability to innovate (CADMOS, 1991:63).

The overall conclusion in the CADMOS study on the areas of innovative activity in Europe is summarised in the following quotation:

"From the overall positioning of regions in Europe one can identify core areas where economic activity and technological innovation is concentrated. First there is the core triangle bounded by Paris (Ile de France), London (South East) and Amsterdam (Noord-Holland), and including the Ruhr Basin. This core triangle is accompanied by other regions that have good accessibility and receptivity to innovative ideas and new investments. In fact, the economic heartland of Europe is running in arc from the English Midlands through the Benelux and the German Rhineland to the North of Italy. Certain areas outside this arc are also centres of economic activity and innovation like Hamburg, Copenhagen and the regions in a line stretching through Southern France to Northern Spain." (CADMOS, 1991:71)

The CADMOS study concludes that if the EC chooses for a scenario of a '*strong EC core*', this would require some adaption of technology policies, i.e. a greater emphasis on diffusion policies, accepting the principle development in the core of the new technologies, but accelerating their use in the periphery (CADMOS, 1991:page 30 of synthesis report).

4.4 *Conclusions*

The sophistication of the innovation model suggests a need for a different approach in the comparison between national systems of innovation. In the linear approach the most important parameters for success in innovation are research inputs and outputs in terms of patents. Most statistics on R&D indicators are based on these parameters, even though they are problematic as we have discussed in this chapter. Comparison in an integrated approach would imply comparing the innovation system's learning capabilities, the absorptive capacity of firms, in short qualitative features for which no satisfying measures have yet been developed. The new approach shows that more empirical research and development of methodologies are necessary to develop a better understanding of national and regional innovation capabilities.

The data that have been presented in this chapter give a picture of large disparities within the Community in terms of R&D input by governments and firms, industrial specialisation patterns, innovation support infrastructure and the ranking in qualitative measures of technological capabilities. Given the incongruity of indicators in the discussed studies it is problematic to give an unambiguous ranking of countries and their innovation performance. Material from empirical research is still too fragmented to give an overall judgement of differences in innovation capability per country. In addition, innovation capabilities are measured using indicators not directly related to diffusion

capabilities. Furthermore the empirical data in international literature are biased in favour of the 'big three', making comparison with the small and less favoured countries difficult.

On the basis of the studies that we discussed in this chapter we can tentatively distinguish three groups in terms of innovation capabilities. The boundaries between the groups are not clearcut and the positioning can change depending on what indicators are stressed.

Strong innovation capabilities can be found in Germany, France, the UK and the Netherlands. The position of the UK in this group is questioned by analysts (Patel/Pavitt (1991), Porter (1990)) and is judged to be deteriorating. As Ergas (1986) pointed out the UK and France do not perform well in terms of diffusion. We should note that in the studies and statistics used, the former East German regions are not included.

The next is a medium group with Denmark, Italy, Belgium/Luxembourg²⁰ and Ireland. Denmark is a high performer in some of the figures, for instance on technology management in the IMD study. In Italy however there is a large disparity between the regions in the North and South. Ireland is on the border of the medium and low performing group in terms of the R&D perspective and industrial specialisation patterns. The IMD and CADMOS study judge Ireland as respectively a good and a medium-low performing country. One explanation can be a time lag between the two studies (1991 and 1993). In the 1992 report Ireland scored 9th behind the Netherlands, Belgium/Luxembourg and UK which it has passed in 1993. So according to this report, its innovation performance is improving rapidly.

Finally there is a low performing group with Spain, Portugal, and Greece. The CADMOS study showed that in the case of Spain there are some 'islands of excellence', which perform very well.

²⁰ Most of the studies and statistics used in this chapter do not include Luxembourg as a separate country.

What is the consequence for all this for the Community's diffusion policy? Diversity and disparate innovation capabilities have gained momentum as a policy issue with the joining of Spain and Portugal as EC members. Their entrance changed the balance more in favour of the lesser developed countries and regions. Social and economic cohesion became an important issue on the agenda of the Single European Act. It also increased the criticism on the 'core oriented' RTD policy. It paved the way for more support for SMEs and for regionally oriented RTD policies. Commission policies had to take account of the contribution to cohesion in all their actions. For diffusion policy this means taking account of different technological needs, technology support infrastructures, learning capabilities and so on.

As we have seen, there is a great diversity in national systems of innovation, in terms of economic structure, R&D efforts, innovation policy and institutional setup. The diversity in itself is not a problem, it can be an asset for European competitiveness to have varied markets, production specialisations and so forth. The problem arises when this diversity reflects an unequal innovation capability of the nations and regions in the Community. If Community innovation support mechanisms rely on the existing national infrastructures for creating and diffusing knowledge and technologies, the participation and impact of such programmes will depend on the quality and quantity of this infrastructure already existing. Countries which have a large amount of firms with in-house R&D facilities will find it easier to participate in the R&D collaborative programmes. The same is true for centres of excellence in research. Countries that find their strength in sectors with predominantly SMEs will face larger barriers to join collaborative projects. Diffusion programmes that rely on existing technology transfer channels, will find a greater reception in the diffusion oriented countries that already have an extended network of regional diffusion centres. This means that the participation in EC innovation programmes is highly determined by existing knowledge base, firms, innovation support services including government support bodies and all other actors involved in projects. Here the tension

between keeping competitive edge in high-technology industries and searching for excellence in research on the one hand and achieving greater coherence by closing the innovation capability gap is most felt.

If cohesion is definitely on the policy agenda, the Commission will be faced with a difficult challenge to pursue a balanced 'dual-track' innovation policy, which on the one hand chooses for maintaining excellence in high technology industries, without on the other hand depreciating the objective of integration by levelling innovation capabilities.

The integrative model learned us that the two processes, creating innovation and diffusion of its results, should not be seen as separate operations. A strategy of creating the new technologies in the core EC countries and then diffusing them to the peripheral parts constitutes several misconceptions and adverse effects:

- we have seen in chapter 1 that diffusion requires more than the passive adoption of 'ready-made' technologies and that the transfer of innovations from one institutional context to another is problematic;
- the uneven distribution of innovation capabilities will be reinforced: innovation itself is a accumulative learning process in which learning-by-doing and learning-by-learning improves future capabilities.

What could be the Community's role in the context of the perspectives of diversity? The establishment of the diversity between the Member States conflicts with the insight of analysts that diffusion is highly dependent on the socio-economic and institutional context. This raises the issue if the EC level is the appropriate level for action towards diffusion. The diversity in the R&D perspective is for a large part a matter of national expenditures in R&D, a policy area in which the EC does not have competence to intervene. It is up to the Member States to decide the height of their public budgets and the type of their R&D support. In addition, the EC RTD budgets are too small to have an impact on the distribution of R&D funds on the European scale. The only active role for the Community is to initiate co-ordination between

the countries in research areas, a task the Community has been performing with moderate success. The Community could aim to avoid that their RTD support schemes reinforce the unbalanced national R&D efforts. This would occur if support programmes are limited to leading edge technologies in strategic sectors or when solely the 'islands of (academic) excellence' in the peripheral countries are able to participate.

The diversity in **industrial specialisation patterns** is again a matter in which the EC does not have much direct influence. This is a long-term historical development, caused by a complex and interrelated set of determinants. The diverse pattern of industries and the uneven spread of industries and firms performing in the 'high-technology' sectors does indicate that EC policy cannot equally please each industry or country. The industries supported by the RTD programmes is thus a matter of political choice. A possible option for EC action is to encourage firm-to-firm networking, to tackle common problems and release firms, in particular SMEs from their isolation. A careful consideration should be made of the geographical scale of these networks, dependent on the needs of the targeted firms. Facilitating standardisation is a policy option to improve the speed of diffusion and harmonisation of markets.

The most prominent role can be played in the context of diverse **institutional contexts**. We have stressed several times that diffusion oriented policies are for a large part shaped by institutional efforts. The EC has a role to play in the debate on and spread of 'best practice' in these institutional arrangements. This includes stimulating the institutional environment that can improve the absorptive capacity and the innovative culture at the firm level.

The following two chapters will investigate the policy options, in the cases of two Community programmes, which have a substantial diffusion orientation.

5. SPRINT: THE EUROPEAN COMMUNITY STRATEGIC PROGRAMME FOR INNOVATION AND TECHNOLOGY TRANSFER

5.1 Introduction

This thesis aims to explore the position and status of diffusion oriented policies at Community level. So far we have looked at the weight of diffusion oriented support mechanisms within overall RTD policy. In the following two chapters we will look at two programmes, each with an important element of diffusion in its mission, and both of them in operation for some years. The case of SPRINT, the Strategic Programme for Innovation and Technology Transfer, is an example of a Community programme which has diffusion as its main mission. Furthermore it has shown a rapid development in its concept of diffusion in the direction described in the first chapter: from diffusion as the last phase of the linear model towards an integrated part of the innovation process.

We have seen in the previous chapter that diffusion gained momentum in the last decade, cumulating in the definition of the 'third activity' within the Fourth Framework programme with a budget of 330 MECU. This activity is called *Dissemination and exploitation of findings*, and it will include both the present VALUE and SPRINT programmes.

SPRINT is the only EC RTD programme with a broad and integrated approach to innovation and diffusion. In fact Commission officials are not unequivocal whether the programme should be seen as a RTD programme, even though it falls within the RTD policy domain in the strategic documents such as 'Research after Maastricht'. Even with the current integration in the Framework Programme some still see SPRINT as a separate type of action.

Within the SPRINT philosophy innovation is not seen as merely a problem of creating new technological knowledge through research. The wider environment of innovation, which is crucial for the exploitation of this technological knowledge is considered to be one of Europe's main barriers to innovation. The non-technological aspects of innovation such as management skills, technical training and finance of technology projects are equally urgent barriers to innovation. The actions of the programme concentrate on SMEs and their need for external sources of competence to achieve innovation. Linking SMEs to the sources of competence, either other firms or innovation support infrastructures forms one of the main support mechanisms of the programme. From the start its concern was to create the infrastructure to provide these links and thus enhance technology transfer.

The leading questions in this chapter will be:

- how has the programme evolved over time in terms of objectives and priority actions?
- what concept of innovation and diffusion can we identify from SPRINT documents and actions and has this changed during its development in time?
- has the programme been successful in contributing to diffusion of technologies and best-practice throughout the EC?
- have the levels of conflict as described in chapter 2 constrained or facilitated the programme's operation and objectives?
- what has been the impact of the programme on the position of diffusion policy in the Commission's RTD policy?

We can distinguish between three levels of analysis: the SPRINT programme, which reflects the general objectives and priorities areas, the action lines within SPRINT, which reflect the support schemes that have been developed under the programme and the contract or project level which reflects the activities being undertaken by selected contractors. The information at this

last level is quite scanty and often confidential. The first two questions will be explored in parallel when discussing the historic development of the programme. The third question will be investigated mainly at the level of the separate Action lines.

The information in this chapter is based on documents published by the Commission in particular the SPRINT office, evaluations made by external consultants, participation by the author in various SPRINT projects and interviews with some of the policy makers and experts responsible for the operation of the programme.

5.2 The historical development of the SPRINT programme

As we have seen in chapter 3, SPRINT is one of the few RTD programmes that is diffusion oriented in its objectives and design. Its mission concerns a wide scope of elements of innovation, which are not addressed by other Community programmes or even by the Member States. Despite the wide mission, it has always been relatively small in terms of budgets. It aims at innovation at an industry wide level, not on specific technologies or 'high-tech' industries.

The Commission of the European Community, Directorate General XIII - Telecommunications, Information Industries and Innovation, Directorate D (before 1993 Directorate C) - Exploitation of research and technological development, technology transfer and innovation is responsible for the SPRINT programme. The management of the programme is undertaken by the SPRINT office in Luxembourg.

The original Council Decision launching the programme in 1983, provided that the Commission should be assisted in implementing the plan by a consultative committee, named the "Consultative Committee for Innovation

and Technology Transfer (CIT)" (Council, 1983). The members of the CIT are representatives from the different Member States. Its goals are to facilitate cooperation between the Member States, to advise the Commission in particular on the priority actions and to evaluate the measures taken. The CIT is still active in the present SPRINT Programme. It meets at least once a year with the main task to give its opinion on drafts of measures to be taken. Its members are mainly national government officials from Ministries of Economic and/or Industrial Affairs.

To support the SPRINT office a Technical Assistance Unit (TAU) was set up in 1990, following a Call for Tender. This unit assists with much of the routine operations involved in the Calls for Proposals, such as registration, producing contracts and a first evaluation of proposals. The TAU also monitors the progress of ongoing projects (CEC-DG XIII, 1991b, 29-30).

Up till 1994 SPRINT has not been part of the Framework Programmes. This had the advantage of having larger autonomy in deciding on the lines of action and new initiatives, the disadvantage however of not being integrated with other RTD programmes. In the fourth Framework Programme, SPRINT will be integrated as part of the above mentioned Third Activity. This could mean that SPRINT as a separate programme will end to exist, since it has to merge with the Value programme. The possible implications will be discussed below.

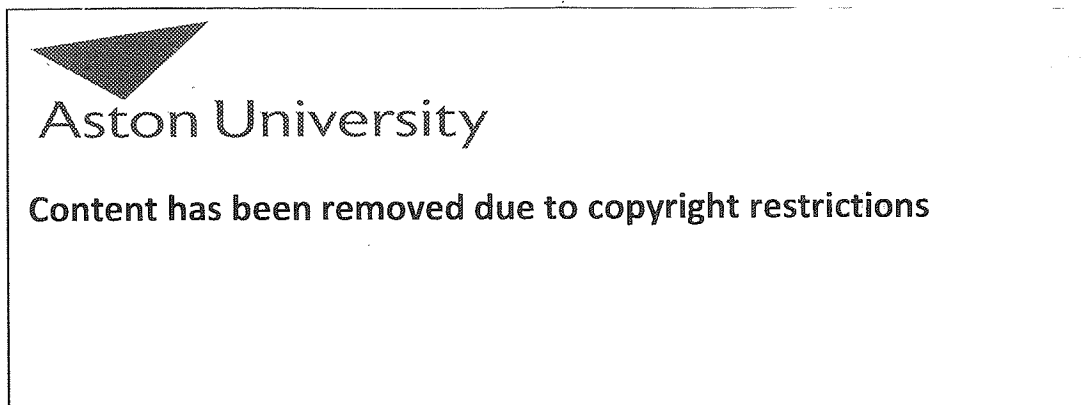
SPRINT's objective is to support innovation in European firms, in particular SMEs, by enhancing transnational diffusion of information and technologies. To achieve this final goal, the programme focuses at the intermediary level: the supporting infrastructure that helps enterprises with transnational technology transfer. These intermediaries vary from innovation support services (public innovation centres, private consultants, regional development agencies, chambers of commerce, etcetera) research organisations (organisations that have access to new technologies and know how) to financial organisations.

The support has a vertical and a horizontal dimension. The vertical dimension aims to improve the innovative capacity at the firm level, either directly or through the intermediaries. The horizontal policies are designed to improve the relations between the intermediaries, through the creation and support of transnational networks of intermediaries and professional associations. This is a slightly different approach from the notions of vertical technology transfer (between research and industry) and horizontal technology transfer (for instance cooperation between research centres or trading in licenses between firms). There is also a third mission of the programme: increase the awareness of the understanding of innovation and best-practice policy support to the Member States. Figure 5.1 gives a simplified model of these levels and the policy dimensions.

5.2.1 The Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer

The SPRINT Programme, launched in december 1986, was the continuation of the "Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer" (subsequently referred to as the Transnational Plan). The plan was put forward by the Commission in 1983 and a positive decision by the Council followed by the end of that year (Council, 1983).

Figure 5.1: Main support mechanisms of the SPRINT programme



The idea for this Transnational Plan was formed during a conference organised by the Commission on "Transfer and Exploitation of Scientific and Technical Information" held in Luxembourg in 1981 (CEC, 1982). DG XIII - at that time called "Information Market and Innovation"- was the organiser. Mr. Gibb, later the first head of the Transnational Plan and subsequently SPRINT, was co-ordinator of this conference. In the opening address Mr. Appleyard, the then Director-General of DG XIII, stated that the DG had been allotted a mission to connect the research carried out by the Commission to the economy. The main problems he saw at the time, concerning the transition of research into innovation, lied in inadequate publication of the research results and in poor protection of the knowledge created in the research programmes. Looking at it from the firm perspective he considered the market transparency for technologies as a major barrier. Both these problems could be tackled by the transfer and exploitation of relevant

information. The SPRINT programme originated from a concern for the exploitation of research results and the dissemination of knowledge, resulting in a "(...) more systematic valorization policy" in the words of Gibb in this conference (CEC, 1982).

The stated objective of the Transnational Plan was:

"... to promote a rapid penetration of new technologies - as soon as they become available - throughout the Community markets. SMEs will receive most attention in this objective." (Council of the EC, 1983)

In this phrasing we can detect a 'traditional' approach to diffusion: the spread of research information and ready made, licensed technologies to firms around the Community. Chapter 1 described that this was still the dominant approach in the early eighties, both in innovation literature and public policy. At this time the linear model of innovation, where research was the main source for new technologies, was irrefutably dominant, particularly at the Commission. Following this approach, information is the main obstacle for diffusion. Setting up human networks as an instrument of technology transfer is mainly seen as a means for communication. In this respect it shows similarities with the Agricultural Extension Services set up in the US to spread information and best-practice to potential adopters of these technologies (Brown, 1981). The concept and profession of technology transfer, was very new in the early eighties. The Transnational Plan was to set up transnational liaison mechanisms for technology transfer and to improve the profession that had only just started. "... it was meant to promote transnational linkages and cooperation between innovation support services, which would create a favourable environment for the innovative efforts of small and medium-sized firms in the Community" (CIT, 1991). The launch of this new plan was not only very experimental, it was perceived to be an activity that had nothing to do with the Community research efforts. Since it was so small in budgets, and

unknown to the rest of the Commission services, it was not seen as a threat to any of the other policy domains, as interviewees pointed out.

The late adaption of the Plan and an acute manpower shortage, caused a large backlog of 'appropriations for commitment' in 1984 and 1985. These teething troubles were largely overcome in 1986. Also setting up the CIT and problems within the CIT due to different interpretations of the Council Decision, delayed the implementation of the Plan in its first year (CEC, 1986d).

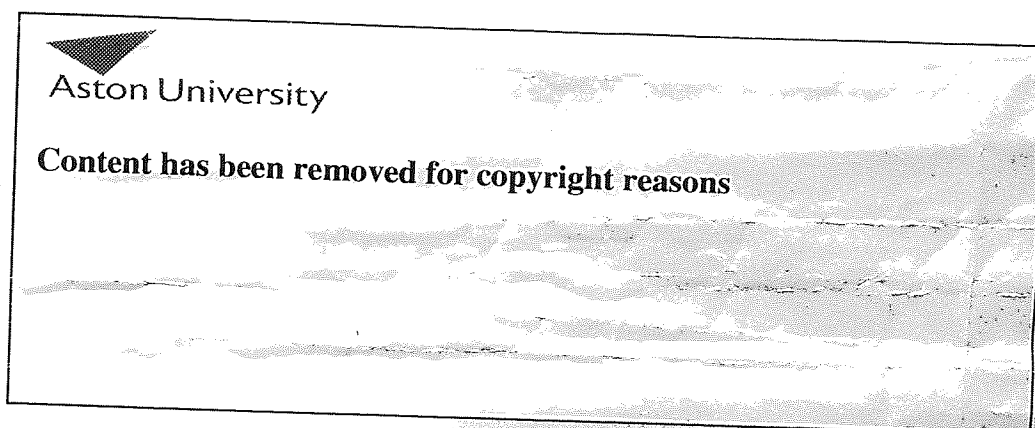
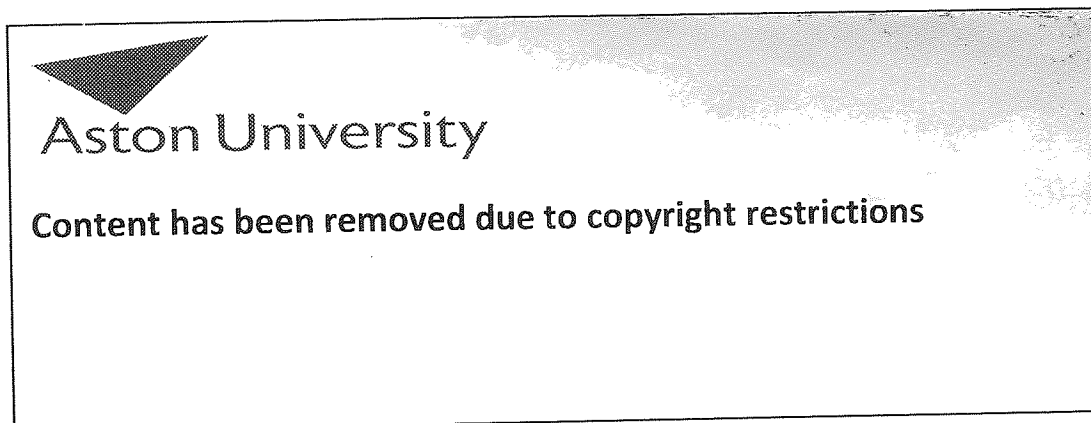
The priority lines set in the Council Decision of 1983 form the basis on which the present SPRINT programme is built. The three priority lines were:

- a. establishment of human networks and liaison mechanisms;
- b. strengthening the foundations (i.e. dissemination of information to firms);
- c. concertation of Member States and Community action (Council, 1983).

In these first few years the goals were still vague and action lines dispersed. The programme was experimental and had little funding (10 MECU for three years). The strategy was based on two main ideas: "the systematization of personal contacts on the one hand, and the organization of the meeting of ideas and information on the other" (CEC, 1986d). Diffusion is thus achieved as the result of personal contacts of people moving to different environments.

The implementation of the Transnational Plan was characterised by a wide variety of actions (more than 20 different ones) that received funding. An overview of these actions, are given in figure 5.2.

Figure 5.2: Actions 1984/1985 proposed by the Commission and approved by CIT



A = Action

Source: Second Annual Progress Report, CEC, 1986d.

This picture shows a diverse and widespread maze of actions, ranging from creating human networks, funding the diffusion of telefax machines among technology transfer centres and general studies on Japanese sources of innovation. The largest share of funds, 3.7 MECU, almost half the total budget was allocated to Action 1, Transnational cooperation of advisory

organisations. The indirect aim was to enhance transnational co-operation between SMEs in the field of technological exchange, in order to achieve a more rapid penetration of new products and services. Since the Commission is not aiming to facilitate these inter-firm links directly, it relies on public and private technology transfer and innovation management advisory organisations to mediate these links. The scheme thus gives financial support to the co-ordination costs of transnational networks of support services. In practice this meant financial support for expenses made in setting up and maintaining these networks and supporting visits and secondments between the various organisations. Networks were set up between innovation support organisations such as consultancies, regional development agencies and chambers of commerce. An example of their activity would be if a private consultant from Germany had a client looking for an international partner, he or she would call in the assistance from the network associates from the relevant countries, to find a suitable partner for that firm. Depending on the mission and professionalism of the support organisations, the two firms could be assisted in their negotiations and agreements.

The SPRINT office wanted to give this action critical mass and guaranteed continuity. Up to this moment this action line is still one of the core activities of SPRINT. Ideally the programme would facilitate the creation of a supporting infrastructure that will give SMEs access to specialised advisory bodies on financial, legal, tax, technological, commercial and management questions (CEC 1986 d and e). Networks were also set up between European research organisations.

Other actions included helping to create professional associations in these new professions. Two of the most significant examples are TII (Association for Technology Transfer, Innovation and Industrial Information) and EVCA (European Venture Capital Association).

The Europeanisation of conferences on innovation and technology received 1.2 MECU or 15 % of the budget (CEC, 1984) . The rest of the budget was distributed over the other actions, not one of them receiving more than 5 % of the total budget.

Systematic reviews of the results of the Transnational Plan and subsequently the SPRINT programmes were made internally in the form of progress reports. The reports were presented in the CIT meetings after which the CIT brought out its advice on the allocation of budgets to the different Action lines.

The first two annual progress reports in 1985 and 1986 mainly showed which action lines were launched (CEC, 1985h and 1986d). Tangible results were setting up of European associations such as EVCA and TII with support from SPRINT. Other activities were only just in the start-up phase.

The second annual progress report describes the Plan as "a controlled environment for experiments, some of which are abandoned... while others seem more likely to succeed (...)" CEC, 1986d and CEC-DG XIII, 1986). This progress report was drawn up by the Commission after consulting the opinion of the CIT on the Action lines. The three years planned duration is considered to be too short to justify a full 5 year programme. A further definition phase of two years is proposed by the Commission.

5.2.2 The definition phase 1986 - 1988

In October 1986, when the Transnational Plan almost reached its ending, the Commission proposed the Council to extend and revise the programme under a new name: the Strategic Programme for Innovation and Technology Transfer (SPRINT) (CEC, 1986g). The Council decided that SPRINT could be launched for a definition phase of two years (end 1986 to end 1988) (Council, 1987). The Commission had proposed a budget of 21 million ECU.

However the Council decided on a budget of 8.6 MECU for two years. The central objectives of the Transnational Plan were still valid for SPRINT. A new aspect was however explicitly mentioned in the proposal: the wish to decrease the differences between the Member States:

".. the disparity between the levels of advice and support available to firms, particularly small and medium-sized enterprises in the different Member States, needs to be reduced by appropriate means such as training of specialists in technology transfer, in innovation management and financing." (CEC, 1986g)

In the definition phase of SPRINT no essential changes were made in terms of action lines. One line of action was added in the Council Decision, i.e. the development of basic and further training for specialists in technology transfer, innovation management and financing.

A Commission publication of november 1986 describing the background of the SPRINT programme, its objectives and the activities to be taken, reveals a 'state-of-the-art' thinking on innovation (CEC, 1986f). It is acknowledged that innovation is more than invention, it also incorporates applications of existing knowledge and products or even identifying new opportunities in the market. Thus innovation support is not just a matter of high-technology, it should be extended to the most traditional industrial sectors and to all types of services, according to this document. It further states that innovations should be pursued to its very end, when it achieves a commercial successful position in the market, which can take months or even years. The document states that success depends on its design, the production of prototypes, the launching of market studies and organisation of distribution channels. This requires not only entrepreneurs who are capable of managing all these facets of innovation, financing these risk-bearing activities is seen as a major problem as well. Thus SPRINT aims to cover all these down-stream barriers to innovation in particular on behalf of SMEs. The target group of support is not the firms

themselves as we have already seen, but the innovation support infrastructure that can support the entrepreneurs to overcome these barriers. The transfer of technology is a key concept in this type of innovation support. In the philosophy of SPRINT technology transfer can be vertical or horizontal. Vertical technology transfer refers to the classic transition in the innovation process from research to industrial production. Horizontal technology transfer refers to the dissemination of knowledge, best practice or technology from one research centre to another or from one firm to another firm. The use of available knowledge and know how outside the firm is a vital strategic element in innovation. The Commission document stressed the importance of specialised intermediaries in this transfer process, to overcome the isolation and barriers that firms can have to find that external information (CEC, 1986f).

The transnational element of technology transfer is considered important, in order to take advantage of the potential of the entire European Community supply and demand for technology. This element has to be stressed by the SPRINT office to ensure the legitimacy of Commission involvement in this type of innovation support.

To sum up the first five years the focus was on creating and improving a Community wide infrastructure for organisations and services in the field of innovation support. The horizontal dimension, linking intermediaries, was thus the dominant support mechanism. In the pilot phase there was still a tendency to see diffusion as the spread of ready made technologies and scientific information. In this line of thinking access to European wide information is the main barrier to diffusion. Transnational networks would increase the international outlook of the national support agencies and thus improve European information and know how flows.

The policy emphasis gradually shifted from creating the infrastructure to improving its professionalism. Learning from each other's experiences in

technology transfer in the networks is seen as a key mechanism, particularly in countries with a less developed innovation support infrastructure. In the first years there were no support actions directly at the firm level. This level of action only gained momentum in the main phase of the programme.

5.2.3 SPRINT: the main phase (1989-1993)

The main phase of SPRINT was finally launched in 1989, after five years of experimenting with the programme and gaining experience with the infrastructure for innovation support (Council, 1989b). The programme was allocated 90 MECU for a period of five years.

The objectives and targets, still vague in the previous years, are crystallized out in the main phase. For the first time, incited by the SEA and the 'European Technological Community', (CEC, 1985e) the preamble of the Council decision refers to other Community objectives in particular the economic and social cohesion principle. SPRINT is given the explicit mission to promote innovation for traditional industries and lagging regions.

"Whereas many recent technologies have yet to achieve their full potential for dissemination in certain traditional industrial sectors or in certain regions of lagging development or industrial decline; whereas their rapid adoption could permit those sectors and regions to make up some of the leeway, thus strengthening their competitive position; (...) In implementing the programme, the specific needs and characteristics of the regions of lagging development of industrial decline shall be taken into consideration." (Council, 1989b)

From 1989 onwards a shift in emphasis can be observed, from the intermediary level towards diffusion of technologies and best practice at the firm level. As aforementioned, during the pilot phase up to mid-1989, the emphasis lay on the creation of intermediary networks, gaining operational experience and achieving network stability. But in the main phase actions were

not longer merely aimed at creating the intermediary infrastructure for innovation support. The networks had to show results: transnational technology transfer between *firms*. This was illustrated by the operations of already existing lines of action and by the launch of new lines of action. For instance the SPRINT supported technology transfer networks were from then on required to achieve signed agreements between firms as a measurement of further support.

The officially stated objectives of the main phase of SPRINT were threefold:

- a. to strengthen the innovative capacity of European firms;
- b. to promote rapid penetration by new technologies and the dissemination of innovation throughout the economic fabric of the Community;
- c. to enhance the effectiveness and coherence of existing innovation and technology transfer instruments and policies, whether regional, national or Community (Council, 1989b).

We can see that compared to the objectives in the definition phase these objectives are less instrumental, in the sense that the focus is more on the underlying purpose of the networks: the innovative capacity of firms. Creating the infrastructure was not longer the main goal, it had become a means. The third, policy oriented, objective had, compared to previous years, become more explicit, less focused on concertation, but equally ambitious.

The main instruments to achieve the objectives were to:

- create a transnational infrastructure of innovation support services: the intermediary dimension;
- promote demonstration of best practice in innovation: the firm dimension;
- stimulate the exchange of experience between policy makers at regional and national level: the policy dimension.

The action lines and matching budgets of the main phase showed large similarities with the definition phase, with the exception of an important new line of Action: Specific projects for intra-Community innovation transfer.

Table 5.1: SPRINT main phase 1989-1993



Aston University

Content has been removed due to copyright restrictions

Source: CEC-DG XIII, 1991e.

We can see that the networks still receive the largest share of funding (almost 39 %) but the Specific Projects, the new line of action receives almost as much with a third of the budget. Specific Projects, which will be discussed in greater detail below, are technology demonstration projects to provide awareness of all aspects in the implementation of new technologies. The financial aspects of innovation receive more attention with a pilot scheme Technology Performance Financing. Buyers of a technological device can make payments to the supplier according to the performance of that device. The supplier receives advanced payments from a bank participating in the scheme. The bank receives a loan guarantee from the Commission should the

technology not perform as expected, in which case the buyer does not have to pay further instalments. Another action introduced in the main phase is the Science Park Consultancy Scheme aimed to bring new or prospective science parks in contact with innovation experts for consultation.

Finally to systemize SPRINT's activities in the policy dimension it launched the European Innovation Monitoring System (EIMS) to generate information for the formulation of innovation policies at Community, national and regional level (CEC-DG XIII, 1990a). SPRINT officials consider the programme's actions to play a leading role to initiate and exchange know how on best practice public policy.

Thus, the main phase of the programme addresses many barriers to innovation related to SMEs: networking with innovation support agents and industrial partners, the finance of innovation, awareness of the implications of innovation through demonstration projects, access to research through science parks and best practice in innovation management. There seems to be a systematisation of support areas into a few main lines. Nevertheless, there are still numerous actions, dispersing the budgets over many separate initiatives.

In 1991-1992 a mid-term review was undertaken by a panel of experts to evaluate SPRINT's objectives, review the main action lines, assess its effectiveness and impact and finally to recommend possible modifications to the programme. This was required under Article 8 of the Council Decision when the main phase was launched. The results were published in 1993 (CEC-DG XIII, 1993a). The panel reached the conclusion that the Commission needs a programme like SPRINT since action to improve Europe's competitiveness "(...) must encompass not only measures to increase the rate of development of technology but also policies which will increase the rate of application. It is through application of new technology to products and processes that improved competitiveness will ultimately be achieved" (CEC-DG XIII, 1993a:55). In this sense SPRINT is regarded to complement other Commission actions, most notably the RTD Framework Programme. The

panel does not consider the large number of often small scale actions as a problem. It derives from the many components of the business innovation process. "Successful innovation requires the systematic integration of all these elements. A key role of SPRINT is to help to tackle deficiencies in each of the component activities that comprise the innovation process and to increase competence in their interpretation. Necessarily this involves a variety of actions;" (ibid. 56) This shows a definite shift in thinking on diffusion and the role SPRINT should play in this complex process. The tasks have become much wider and complex than facilitating access to information.

The panel reached the conclusion that SPRINT should play a proactive role to identify the changing needs for organisations involved in innovation. Therefore it should be a flexible programme with a wide scope of actions. The panel proposed that more emphasis should be given to experimenting with new support mechanisms rather than setting up actions which require long-term support. Expansion of the programme's budget is judged to be fully justified (ibid.).

SPRINT, formerly a programme 'hors cadre' i.e. outside the Framework Programme, is to be integrated in the 4th Framework Programme. Since the decision on the contents of this FWP showed long delays due to the new procedures, SPRINT received a budget extension of 22,8 MECU for 1994. In the 4th FWP SPRINT will merge with the activities of VALUE into the third activity of "dissemination of research results and exploitation". The precise organisational structure and the distribution of budgets have not been decided on presently. The Third Activity has two subtitles: "Dissemination of R&D results" and "Dissemination of technologies to enterprises" which seems to reflect respectively VALUE and SPRINT. The latter is again split up between "transnational networks for technology transfer" and "absorbition of technologies by industry" (CEC-DG XII-1994).

Some Commission officials involved with SPRINT fear it could lose its specific character, firstly by the integration into the hierarchical and legal structures

of the FWP and secondly by the merger with VALUE, which has a very different approach to diffusion. VALUE which deals with the exploitation of R&D results from Community programmes, has a philosophy more in line with the linear innovation model as we have seen in chapter 3. It is for the future to learn whether the balance will shift in favour of the tradition of research dissemination or innovation.

5.3 *SPRINT's contribution to the diffusion throughout the EC*

We have up to now mainly investigated the programme level to judge how SPRINT has performed and how the diffusion concept has changed during the years. To gain a more detailed insight in the practice of diffusion support and discuss some of the results, the analysis will move to a lower level of aggregation: the action lines within the programme. Since there have been many of them dispersed over a range of topics, the key action lines, in terms of budget have been selected: transnational technology transfer networks and specific projects. Each of these two is focused on a different target group, respectively intermediaries and firms.

5.3.1 Transnational technology transfer networks

The very first and most significant action line in terms of allocated budgets is that of *innovation support services networks*. In the Transnational Plan this was action line 1: transnational networks (Council, 1983). In 1983 the action aimed to improve existing infrastructures at the national level by giving them a transnational dimension, through communication and co-operation mechanisms. The instrument to achieve this was based on "... establishing networks of specialist intermediaries, with the main aim of promoting innovation and technology transfer through transnational cooperation between

firms" (CEC, 1986d:8). The specialist intermediaries are public or private innovation consultancies and brokerage services committed to assist SMEs in technological co-operation. The rationale for this action was the need to increase the competitiveness of innovative SMEs in the Member States. The transnational networks would increase the technological options of the firms that consult one of the network members in one of the European regions. The aim was to encourage SMEs finding partners in other countries, using the links with foreign advisory bodies in the network. In addition, the advisory bodies would assist the SMEs to manage the technology source within their business strategies. The action line had therefore three objectives:

- to strengthen the European innovation and technology transfer support service infrastructure;
- to develop the technology transfer profession;
- to facilitate the diffusion of new technologies and knowledge to firms through the networks (CEC-DG XIII, 1991d).

Following the first objective the idea was that the intermediaries, working with their partners from other countries, would exchange experience and work methods and thus disseminate best practice in technology transfer. This would make each member of the network more efficient. The cohesion principle was an important underlying factor: intermediaries from LFRs could learn from their more experienced partners in the developed countries.

The networks were allowed considerable time to build up, getting to know each other and their methods of work. This would then result in the actual exchange of innovation between firms. The financial support by the Commission, - 50 % of the costs for maintaining the network - was given for one or two years. Later the period in which networks could be supported was extended to five years with a ceiling in payments and a declining contribution after the third year (CIT, 1990).

According to the first evaluation made in 1985 by the Commission, the CIT and the technology transfer experts involved in this action were very positive (CEC, 1985h). The experts claimed to have gained a better European dimension in their activities, to have learned from their foreign partners and improved means to increase activities for their clients (ibid.:13). An external evaluation was not carried out. The Action line received additional funding in the SPRINT definition phase. In the first two calls for proposals, 47 transnational cooperation projects, involving 120 advisory bodies, were selected. In the second progress report (CEC, 1986d) it is stated that the first actual exchanges of technology - between firms - that are directly attributable to the network mediated partnerships, had started to take place. According to this report, due to the complexity of the process this happened very slowly. By that time the Commission realised that the advisory bodies should have certain characteristics - sufficient size, experience and staff - to be successful in the networks. How these characteristics were assessed for each potential network member was not disclosed. In the selection criteria of the subsequent calls for proposals the emphasis shifted to the network's capability and methods to actually achieve co-operation between firms (CEC-DG XIII, 1989b).

After the action line had been in operation for some time, the SPRINT service stated that certain geographical gaps needed to be filled, particularly in the peripheral regions. In December 1986 the Commission proposed a (revised) list of priority actions, which included the training of technology transfer specialists on the management and financing of innovation. The main argument was to reduce the disparity between the levels of advice and support available to firms in the different Member States (CEC, 1986g).

During the definition phase in 1987, the 4th Call for proposal was published (CEC, 1987c). By that time 46 cooperation projects involving 150 advisory services were supported. They were spread throughout the Community and

extremely diverse in nature. They included mostly regional development agencies, Chambers of Commerce, technology and licence brokers, and private management consultants (CEC, 1987c). In these figures published by the Commission, no indication was given of the achievements relating to the final objective of this action line, i.e. encouraging international exchanges of technology between small and medium sized firms.

The SPRINT service drew the following conclusions regarding network participation in the first years of the action line:

- networks had a high turnover in membership. Of the 140 bodies that were a network member in 1989, only 11 % were present during the first year of SPRINT. 75 % had been eliminated or left the programme.
- There were regional imbalances between countries and regions, imbalances of participation, but more importantly profound structural imbalances in performance (CEC-DG XIII, 1989a:4). Some Member States were well represented, some were badly represented. This was due to on the one hand imbalance in the response to calls for proposals, on the other hand some countries were more preferred as partners than others.
- Organisations from a number of Member States such as Italy and Greece seemed to have more problems in staying in their networks than organisations from other countries.
- For a number of countries, mostly smaller countries it was difficult to diversify the type of organisations involved, they always seemed to have the same kind of organisations in the networks (CEC DG XIII 1989a and b, 1990c).

Between 1985 and 1990 a total of 250 agreements between firms were made through the intermediaries in the network. These agreements could be the technology licenses, in some cases complemented by training from the supplier, joint development of a technology or mere distribution agreements.

One of the problems SPRINT officials wanted to deal with, is how to give the networks a better Community balance. The regional imbalance of the networks has changed since the first years of the main phase of SPRINT. Figure 5.3 shows the change in the number of organisations participating from each country. The name of the action line had changed from Transnational Technology Transfer Networks to Inter-firm Agreements Networks. This can be seen as another indication that the emphasis was now on achieving collaboration between firms and not merely between intermediaries.

Figure 5.3: Origin of the network participants



Aston University

Content has been removed due to copyright restrictions

Source: CEC-DG XIII, 1989a and 1990c.

The figure shows that the three large developed countries, France, UK and Germany are taking a clear lead position, followed only by Spain. France has an exceptionally high participation compared to the rest. As it concerns network members of which the regional spread is a good criterion of the

action's impact, we should expect that the larger the country, the more members it has. Purely on the basis of the size of countries, we would expect France and Spain to have lead positions, followed by Italy, Germany and the UK and then followed by the smaller countries. In this sense, Spain and Italy perform worse than expected. A better criterion would be to compare the spread of network members with the population of SMEs in each country. From data published in the European Observatory for SMEs, we can roughly distinguish three groups of countries, based on the number of firms with less than 500 employees (European Network for SME Research, 1993:60). First a group with more than 2.000.000 SMEs²¹: Italy (3170), the UK (2630), Germany (2160), France (2040) and Spain (2020). The second group has between 420.000 and 670.000 SMEs: Greece (670), Portugal (640), Belgium (530) and the Netherlands (420). Finally the last three countries have less than 200.000 SMEs: Denmark (180), Ireland (130), and Luxembourg (20). If we compare the number of network members with the number of SMEs in each country we see that Italy and Greece are severely underrepresented. In reality the geographical distribution will be highly influenced by the number of innovation support agents in each country, and especially those that have an international outlook. It is therefore striking that Germany does not score higher, since its technology transfer infrastructure is highly developed. We saw a similar pattern with TII membership in chapter 4. If we compare the number of participants in the two years we can see that the countries of Southern Europe, Spain, Italy and especially Greece and Portugal have improved their position considerably. The smaller developed countries have a low membership in the networks, especially the Netherlands and Denmark. The overall picture is that the gap between the 'top division', those countries with more than 25 participants, and the 'lower division', those with less than 15 participants, has widened.

²¹ Figures in brackets are enterprises x 1000, with less than 500 employees in 1988.

In terms of results from inter-firm agreements and the flow of technology between suppliers and receivers, there are countries that have a clear surplus of technology suppliers, i.e. UK, France and Belgium, countries where both are in balance, i.e. Italy, Germany and Denmark, and countries in which the firms are predominantly receivers of technology, i.e. Spain, Portugal, Ireland, Greece and in a lesser degree the Netherlands²² (CEC, 1990a). These figures indicate that the contribution to cohesion of this SPRINT action is low at the level of the innovation support infrastructure - the intermediaries - on the other hand significant at the firm level. The flows of technologies, diffused from one country to the other are predominantly going from the developed to the less developed countries.

In the main phase of SPRINT the Technology Transfer Networks, still form an important component of the programme. Networks of innovation and technology transfer consultants were not the only type of network supported by SPRINT. More specialised networks of sectoral collective research centres, contract research organisations and financing bodies were set up. Alongside the networks several accompanying Network Support Measures were launched such as Technology Transfer Days, where companies of a specific region are brought in contact with technology brokers from different regions of the Community.

In 1991-1992 the first external evaluation of the main part of the Action line 'Technology Transfer Networks' was carried out by a consortium of consultants (SQW et al.²³, 1993). The report observed a similar shift in emphasis in the action line of Technology Transfer Networks as was pointed out for the overall SPRINT programme: first the emphasis was on creating the

²² Luxembourg was not involved in any agreement

²³ Author of this thesis was involved in part of the fieldwork for this evaluation as member of the Dutch consultant TNO - Centre for Technology and Policy Studies.

transnational infrastructure of intermediaries and enhancing their professional capacities. When experienced networks started to emerge, the emphasis shifted towards an expectation that they would produce tangible technology transfer results, in particular inter-firm agreements. This represents a shift from the first objective, improving the intermediary level, to the second, intensifying the diffusion of technologies between firms. A shift to the second objective would have positive feedback to the first because professionalism would speed up in the process of pursuing the agreements.

The result of this shift is that the selection criteria for participating in the networks became more stringent and targeted to achieving agreements (SQW et al., 1993:8). Existing networks were inclined to put pressure on their less effective partners to improve their methods or either leave the network.

The actual output in terms of technology agreements between firms has increased substantially but the evaluation at the same time expressed a reserve in assessing the value of this indicator. The networks are required to declare the signing of agreements as part of their reporting process to the Commission. The value of these agreements in terms of the technology transfer component involved remains unclear. Many of these are commercial contracts, such as sales agreements, rather than agreements with a technological content (SQW et al., 1993). This raises the question whether two or more firms which did not collaborate before, are prepared to share vital technological knowledge after a first contact made by the intermediaries. It could be that a commercial relationship is the first step to further collaboration on more strategic aspects of business. Only if the technologies are well protected through patents and clear license agreements, such a fast contact could lead to immediate technological collaboration. This could result in collaborations limited to the exchange of 'ready made' artefacts.

The evaluation team noticed a difficult alliance of objectives within the action line: "In principle, it attempts to pursue two objectives in one scheme: (professionalism), and cohesion (transnational transfer of competence, learning)" (SQW, 1993).

The evaluation showed that effect of this tension has been that the networks are built around participants with differing technology transfer capabilities. There has been a mix between private partners with a focused technology transfer mission and public organisations with a much wider mission than technology transfer, such as chambers of commerce and regional development agencies. The technology transfer specialists often located in the industrially most developed parts of the Community, found the effectiveness of their network hampered by these differences in capabilities and working methods. Another point of criticism revealed by the evaluation, was the wish to give the networks a Community wide representation, which made the networks too large to be effective. This put a large burden on the co-ordination efforts and the network commitment. Although the objectives of best practice and cohesion may conflict, the team suggests that they can be combined effectively. The report finds that the highest penetration of the SPRINT action, i.e. number of network members compared to the population of technology transfer agents, has been in Greece and Ireland. One could conclude that this more likely to be caused by the small number of technology transfer agents in these countries than by the high numbers of participation.

The second objective of the Action, transnational cooperation between firms is judged to have shown less tangible results. The overemphasis on achieving agreements as a criterion for SPRINT support, made the lesser experienced and specialised intermediaries neglect their supportive task towards the SMEs. For instance providing advice to SMEs in understanding how the agreements could fit into their business strategies, was a task that not all intermediaries could perform satisfactory. The second objective was considered to be too unrealistic given the setup of the network at the moment of the evaluation (SQW et al., 1993). The SPRINT service seems to have learned from these

comments and decided that in the future the emphasis will be on 'mini-networks'. This means that there will be a careful selection of networks of specialised technology transfer experts on the one hand and public networks on the other hand which will be given tasks in the accompanying measures, such as organising the Technology Transfer Days (CEC-DG XIII, 1994). In this setup best practice technology transfer will not be hampered by a 'forced' Community wide representation.

5.3.2 Specific Projects

The main phase of the programme, which started in 1989, introduced a new Action line: Specific Projects. These are large scale technology transfer demonstration projects, that show not only the technology that has been transferred but also the human, organisational and business processes that have been adapted to implement the technology. This is the first major action for SPRINT that concentrates on the firm level: both suppliers and end users of available technologies are involved in the project implementation (CEC-DG XIII, 1989c, 1992c).

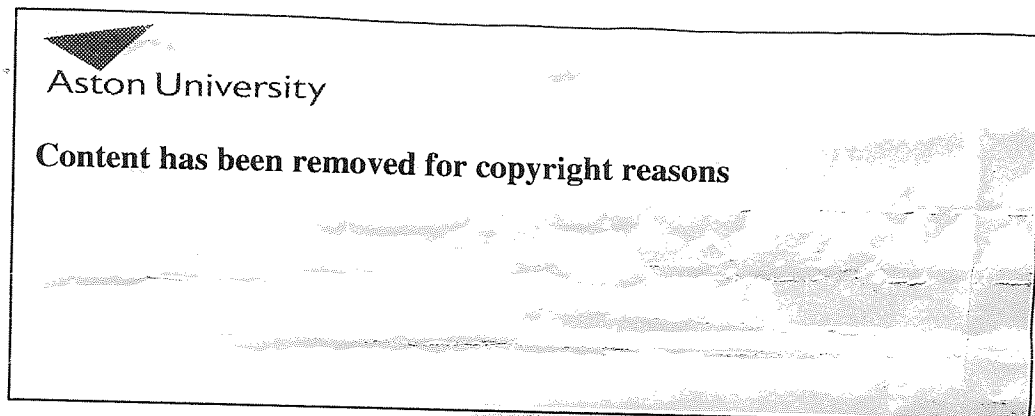
The stated objectives of the Action line are:

- to facilitate the effective adoption of new technologies by companies
- to encourage transnational cooperation between bodies and companies with complementary skills
- to demonstrate all elements for the adoption of a new technology
- to demonstrate the effectiveness of partnerships between complementary bodies
- to demonstrate the benefits of special management techniques.(CEC-DG XIII, 1991d).

The focus is very broad, no particular industry or technology is targeted. "There is, however, a focus on supporting the modernisation of small and medium enterprises, traditional industries (e.g. foundry, textile, shipbuilding), on projects with an environmental dimension (e.g. water and sewage treatment), and those with strong 'social' benefits by integrating disabled people or increasing safety and health at work" (CEC-DG XIII, undated b:3). There should be a strong user orientation in the supported projects. Supported projects first enter a definition phase of 6 to 9 months, to establish the feasibility and define the subsequent phases of the project. The Commission will finance parts of the budget in the definition phase, after which it decides whether it continues the project. The overall aid for a multi-annual Specific Project is 50 % of the total budget.

This is the first major line of action with specific targets directly towards industry: promoting the application of 'broad spectrum' technologies in traditional sectors and/or sectors with a low technology intensity, alongside sectors with a high 'social' utility. Proposals for projects must effectively involve well identified companies which are committed to implement the proposed technologies. The interesting new policy element involved in this line of action is the 'global approach' to the adoption of new technologies. The philosophy is that companies should be made aware that adopting new technologies does not only concern the technical performance but also the practicalities of implementation concerning organisation, distribution channels, staff retraining etcetera. So each Specific Project should demonstrate this broad array of business functions affected by a new technology. Looking at the choice of projects after the action line is three years in operation we can see the following type of projects being supported:

Table 5.2: Type of specific projects



There is some overlap of categories: for instance some of the environmentally oriented projects are for a specific industry. The spread of the type of firms, sectors and technologies seems indeed to be very wide.

Figure 5.4 shows us the geographical distribution of the partners of Specific Projects from the 1989 and 1990 call for proposals. France is in the lead position having the largest number partners, although Germany has most leading partners. Greece has a remarkable large amount of partners in the Specific Projects. Striking is a relatively small interest for this activity from the Benelux countries and Ireland. We can conclude from this figure that despite the emphasise on traditional and low technology sectors, the more developed countries still have a prominent participation in the Action line. They are often the supplying side in the demonstration projects. However countries with many less favoured regions are well presented, particularly Greece, South Italy, Spain and Portugal. The demonstration projects could have clear contribution in diffusion of best-practice and given the regional distribution to economic cohesion. The projects are still in their implementation phase.

Demonstration projects, because of their 'near market' position have been looked at with some suspicion by Commission policy makers. However with the increased attention for the role of SMEs in the innovative fabric of the

EU including SMEs in traditional sectors, demonstration project such as the Specific Projects have managed to gain momentum. The required demand orientation and the emphasis on the non-technological aspects of innovation, illustrate that this action line includes some of the key elements of an integrated approach to innovation and diffusion. This is a very unique approach to demonstration projects which are most often focussed on merely the technological aspects of new innovations. An external evaluation of this action line is in progress at the moment of writing this manuscript, unfortunately the results are not publicly available yet.

Figure 5.4: Geographical distribution of Specific Projects



Aston University

Content has been removed due to copyright restrictions

Source: CEC- DG XIII, 1993d.

5.4 *SPRINT's position within EC policy: constraining and facilitating factors*

SPRINT has evolved from a marginal programme operating in isolation, to an established programme with a distinct role in innovation policy. From the very start of the programme the budgets allocated to SPRINT have been small in comparison with the major RTD programmes, but in the 'second league' of programmes, it does not perform badly. Figure 5.5 allows to make a comparison with other programmes in operation in the Second Framework Programme.

Figure 5.5: Annual budgets of major EC RTD programme



Aston University

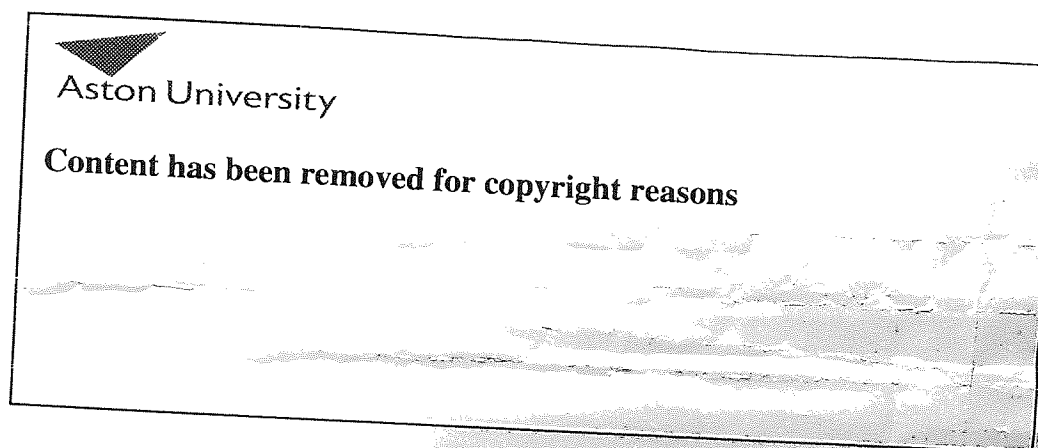
Content has been removed due to copyright restrictions

Source: CEC-DG XIII -1990d.

However since SPRINT and VALUE are the only programmes with a clear mission for diffusion, their relative position is weak. Of course there are other programmes which have diffusion elements in them, including those that fall

outside RTD policy (STRIDE). The next chapter will explore the role in diffusion of one of the 'top four' programmes: BRITE/EURAM. If we look at the increase of budgets for every new phase of the programme, (table 5.2) we can see that SPRINT budgets have increased faster than total RTD budgets in the Framework Programmes (excluding those financed by the Structural Funds). The increase from definition phase to main phase has been dramatic, which shows commitment to the programme's objectives.

Table 5.3: Increase in budgets for SPRINT



- * The third activity (SPRINT and Value) has received 330 MECU for four years. The allocation of budgets to the action lines in both programmes has not been decided yet. This figure is based on the assumption that the ratio between the two will be similar as it was for the main phase of SPRINT (90 MECU for four years) and Value (38 MECU for four years) .

In terms of absolute budgets SPRINT has always been a 'dwarf' in EC RTD perspective. As budget allocations in most bureaucratic organisations are made in accordance to past budgets, SPRINT's modest start in 1983 set the limits for further growth. On the other hand we have to bear in mind that the programme has a different support mechanism than most of the other programmes which support 50 % of the costs for - often large scale - collaborative research projects. SPRINT's financial commitments are aimed to trigger networking, learning processes, demonstration projects and so on. For a large part this means supporting co-ordination costs, travel expenses,

meetings and conferences. The amounts needed for each action they support are much less compared to the reimbursement of the costs of research projects.

From the very start in the days of the Transnational Plan the programme seemed to be quite harmless to both other policy domains of the Commission and to the national states. The then Head of the Plan stated that at that time of 'Eurosclerosis' in the early 1980s, national policy makers were very suspicious of EC programmes which had elements of industrial policy within them. So at the start of the programme the conflict between Member States and the Commission on competence over industry oriented programmes set the boundaries for SPRINT much more than any internal conflict did.

The Council decision was taken very fast and without any conflict according to a Commission official actively involved in that process. The plan was taking the mission of DG XIII - dissemination and exploitation research - one step further towards the commercialisation of these results. In its first years the programme could develop in 'splendid isolation' and therefore experiment with new actions. The activities were not seen to fit in the core part of the Communities' RTD policy. The relationships between SPRINT and DG XII programmes were and still are very few. The traditional linear approach to RTD and its contribution to innovation that were dominant in the overall policy were not threatened by such a small programme. At best the two different type of activities were considered to be complementary.

Competition policy operated by DG IV, placing the large RTD programmes under scrutiny, hardly affected SPRINT. The fact that the programme was small, mainly concerned with intermediaries and not directly with firms and dedicated to SMEs, made it possible to launch 'near to market' actions such as demonstration projects.

With the evolution of SPRINT's profile, its success with its action lines, attention from other policy areas started to grow. This was a two way process: with the Single European Act the commitment for both cohesion and the role of SMEs in the economic fabric of the Community increased. Since Sprint activities incorporated both these areas its type of activities found assent from other EU directorates, those for regional and SME policy in particular. The network approach which offered a regionalisation of policy implementation at proximity to the SMEs was copied in different forms. A complex set of partly overlapping networks of intermediaries, information centres and other support organisations was the result.

SPRINT's overlap with regional policy originates from its mission to support the less favoured regions: "In implementing the programme, the specific needs and characteristics of the regions of lagging development or industrial decline shall be taken into consideration" (Council, 1989b). In the same decision on the main programme it is explicitly stated that it is appropriate to coordinate the SPRINT actions with the policy in favour of SMEs developed by the Commission. However coordination and joint action has occurred only sporadically. On the contrary the different units in the directorates compete for competence in areas of action, such as building up innovation support infrastructures, promoting networks of SMEs and schemes to promote finance for innovation. The gap between DG XIII and DG XXIII seems immense and the geographical distance between Luxembourg and Brussels contributes to this as well.

In regional policy a recent trend is the shift of activities funded by the Structural Funds from investments in the physical infrastructure to efforts to set up a regional innovation infrastructure and or improve the existing structures. In 1993 this led to a collaboration between SPRINT and DG XVI to launch a pilot Regional Technology Plan (RTP) and a scheme for Regional Innovation and Technology Transfer Strategies and Infrastructures (RITTS). This seems a first step to a more to long-term co-operation in action on innovation.

Within overall Community RTD policy, SPRINT has established status as a programme that addresses one of the core problems of European firms: to absorb and exploit the knowledge and technologies available and to turn this into new products and services. It was given the opportunity to develop experimental support actions addressing a wide range of business functions and learning skills. These include for instance networking abilities, management of innovation, finance of innovation. SPRINT has in common with most other RTD programmes that it is engaged in the support of innovation. The difference is that it operates predominantly from the intermediary and firm perspective, rather than from the science and research perspective.

5.5 SPRINT's impact on the approach of policy makers towards diffusion

Has SPRINT managed to influence policy making outside the scope of its own actions? Given the experimental character of its support mechanisms and its early awareness of the integrative approach to innovation, one could expect a positive influence on best practice policy making.

The policy impact of the programme has two directions: towards policy makers in Commission RTD areas and towards policy makers in the regional and national governments.

From an early stage the SPRINT programme was based on ideas of innovation that reflected the newest insights. Firstly innovation was seen in its widest sense: not only research led invention is a crucial element of innovation in the firm, so are technology diffusion, organisational learning and access to risk finance. Reducing the time between invention and market launch of new products, one of the major problems European firms are facing, compared to their Japanese competitors, is very much dependent on these 'downstream' phases of innovation. The SPRINT approach shows awareness that particularly

SMEs face various bottlenecks to innovation not directly related to their research performance. Public support which concentrates on R&D subsidies is only addressing part of the firms' problems. Furthermore these problems are not easily dealt with through direct financial support. They are too specific and too diverse to be dealt with in general support schemes directly to firms. It is the supporting environment of firms that can stimulate them to overcome their problems.

"In order to develop, they must have easy access to specialised advisory bodies on financial, legal, tax, technological, commercial and management questions" (CEC, 1986d, Annex II:6).

The SPRINT programme does not only propagate a different approach to innovation, but also a different role of public authorities to deal with its support. While this different approach already gained momentum in a few Member States such as Germany and Denmark, at the Community level it was quite unique. Although the programme has received an established place in EC innovation policy, given its small size and its aforementioned isolation, its impact on the linear philosophy of the bulk of EC RTD programmes has been minimal.

A SPRINT attempt to change this model of thinking and start a policy debate was initiating the aforementioned publication, the 'Maastricht Memorandum'. In this report a group of experts, including some of the SPRINT officials, expressed the importance the integrative approach to innovation and the consequences for EC policy (Soete/Arundel, 1993). In May 1994 SPRINT organised a policy debate workshop on the implications of an integrative approach to innovation, with EC policy makers, academic experts and innovation practitioners. One of the conclusions was that the thinking of policy makers and experts is shifting towards this integrative approach, which attributes a large role to diffusion of technologies. However, the implementation of integrative policies is still not high on the agenda of national and international governments. A shift in focus in favour of the new approach can be observed in Commission statements as we have seen in

chapter 2. Nevertheless we also saw in chapter 3 that the implementation of RTD policies does not show this shift as clearly.

A new paradigm in thinking on innovation give uncertainties in policy making: new type of instruments have to be developed. What works and what does not has to be explored through trial and error. This is exactly the task that SPRINT is aiming to achieve, according to the present Head of the programme. The experimental approach has been possible because of the relatively isolated and marginal position of SPRINT within the overall EC RTD policies. All the new things that have been developed, were possible because SPRINT was not incorporated in the hierarchical structure of the Commission: its financial/legal position have not been at stake. Commission officials consider it a fortune that SPRINT could develop in isolation.

SPRINT's impact on policy making is much greater at the national and regional level. This is part of its mission as put down in the Council Decision as the third objective "... to enhance the effectiveness and coherence of existing innovation and technology transfer instruments and policies, whether regional, national or Community", which resulted in the European Innovation Monitor System (EIMS). In the context of this initiative studies and surveys are performed "to provide policy makers with the information and understanding they need to improve Innovation and Technology Transfer (ITT) in Europe" (*Innovation and technology transfer*, vol.15/2, April 1992). Surveys on (regional) support infrastructures and mechanisms provide a comparative knowledge base and a tool to work on best practice in innovation support. Innovation policy exchange workshops for Community policy makers are organised to share experience on the support role for governments in different aspects of innovation policy. Through the network actions many regional policy makers have been involved in the SPRINT activities. Very often they find not only the financial support but also the platform for exchange of experiences they cannot find in their nation states.

A clear result of the SPRINT actions is that they enhanced awareness of the importance of networking - between intermediaries, intermediaries and firms

and between firms - as important element in innovation, in which governments have a role to play. We can presently distinguish many national and regional initiatives to create and support these networks (Fahrenkrog/Boekholt, 1993).

To conclude SPRINT has had a greater impact in generating and spreading ideas on a new type of innovation support to the national and regional policy makers, than it has managed to influence the position of and perception of diffusion within the Commission.

5.6 Conclusions

The SPRINT Programme is more than a programme dedicated to diffusion of technologies from one type of firm, application or region to another. Its philosophy and support actions focus on the absorptive capacity of firms in its widest senses. Access to new technologies or new applications is only one of the barriers to innovation that this programme aims to address. Over time the programme has evolved from a rather narrow perception of diffusion and technology transfer to this wide ranging and thus complex mission.

Looking at the development in the aims and objectives of the SPRINT programme from 1983 to the present main phase of the programme, we can see some important shifts in the perception of diffusion.

At the very start access of information on technologies and knowledge was judged to be the principle barrier to transnational diffusion, the programme would address by increasing market transparency. Diffusion was still very much in line with the linear model of innovation, where it forms the last phase of a process that started with (Community) research. Very rapidly other barriers to diffusion such as finance of innovation were considered as policy issues.

In the first years of the programme efforts were entirely aimed at the intermediate structure of innovation advisory and supporting bodies. This is what Brown (1981) referred to as the diffusion agents (see chapter 1). The main idea was to create transnational cooperation in this infrastructure and additionally disseminate information on technology. The final objective, the transnational cooperation between firms, would derive from the increasing international outlook of the advisory and supporting bodies. We could describe these first years as 'creating the infrastructure'. SPRINT has stimulated the professionalisation of the technology transfer agents by spreading 'best-practice' of advisory methods in the networks.

The main phase of the programme on the other hand developed towards "making the infrastructure work for firms". In the course of the programme more industry involvement is required in both the new lines of action as in some of the existing ones. This could be seen as a movement closer towards the market. The period in which this took place i.e. the late 1980s, parallels the increased EC competence in industrial policy as shown in the second and third chapter. The vertical dimension - from intermediary to firm - has gained importance compared to the predominantly horizontal - from one intermediary to another - orientation. Given the small size of its actions the macro economic impact on the competitiveness of SMEs is negligible. SPRINT's impact has been significant at the level of intermediaries and at the policy level. Since its character has been highly experimental, its impact at the firm level has been very modest (small). In one of its main action line (inter-firm agreement networks) the firm level has not been sufficiently reached as we have seen in paragraph 5.3.1. The number of Specific Projects within the European economic fabric are so limited, again its effect must be appreciated as a possible best-practice policy example, rather than a significant tool for European SMEs.

SPRINT has evolved into a programme that experiments in support mechanisms addressing the innovative environment of SMEs and thus enhancing diffusion. Very early in its existence it showed a 'global approach' to innovation and gradually it incorporated those parts of the 'integrative approach' that other EC RTD programmes neglected. The main drawback of this broad approach is that SPRINT actions tend to be dispersed over so many different actions and issues that none of the actions has enough critical mass to have an economic impact or status in the Member States. This has also caused the dispersion of the 'clients' of the programme. Therefore SPRINT does not have a powerful lobby group to plead for its case in the Member States or in Council Meetings.

At the start of SPRINT the level of conflict between the Member States on the one hand and the Commission on the other was most decisive. This led Sprint to be cautious not to emphasis the firm level too much, since this would fall outside Commission competence. The transnational element and SMEs as target group had to be constantly stressed to avoid criticism. In the second half of the 1980s the conflict over industrial policy took place within the Commission, with DG IV being the main guardian of an anti industrial policy perspective. SPRINT could avoid much of this conflict, since it aimed at SMEs which was deemed to be quite harmless, and because there were hardly any direct firm support mechanisms. Even though the Specific projects were much more oriented at the firm level, being demonstration projects they were under less scrutiny.

The increased status of the cohesion and subsidiarity principle from the late 1980s has strengthened SPRINTs position within the Commission, since the type of support mechanisms SPRINT developed, combines very well with these principles. SPRINT actions, targeting from the start on traditional sectors and less favoured regions, made a fair contribution to cohesion. The case of the Technology Transfer Networks showed that this commitment led

to a tension between a choice for the best possible effectiveness of networks and a Community wide spread of network members.

The officials involved in SPRINT perceive the autonomous position of SPRINT being constantly under threat because it moves on the cross roads of many policy areas. As aforementioned, fights over competences form a constant domain of conflict as present in any national or international bureaucracy. The situation at the Commission is even more complicated because of more levels of conflict. Chapter 2 described how national interests and internal fights over competences are intermingled in the policy making process. In addition, it has to stand up in a policy culture where the dominance of the linear innovation model is still very much felt.

At the moment of writing, the future of SPRINT as a separate programme is uncertain, not however its actions. The Research Council has still to decide on each separate programme how budgets will be divided over programmes and action lines.

6. SUPPORT FOR INDUSTRIAL TECHNOLOGIES: THE CASE OF BRITE AND BRITE-EURAM

6.1 Introduction

The programme for Basic Research for Industrial Technologies for Europe (BRITE) and its subsequent follow up schemes, are aimed to support collaborative research by firms and research organisations. Of all collaborative research programmes at Community level, BRITE is one of the most diffusion oriented support schemes. Some of its features make the programme different from many other EC collaboration programmes:

- it aims at generic technologies with possibilities for cross-sector applications;
- at the start of the scheme in 1985, traditional industries were focused rather than high-tech industries. In its later years manufacturing industry in more general terms is addressed;
- during the years the programme has developed separate action lines to attract more SMEs.

This combination of factors makes that the scheme emphasises the application or combination of existing knowledge more than the creation of radical new knowledge. We have seen in chapter 1 that these are important characteristics of diffusion oriented support mechanisms. In addition BRITE-EURAM and ESPRIT are the programmes within the FWPs, that are most likely to have an impact on industrial diffusion. ESPRIT however has a much narrower technological and sectoral objective. Besides it has been in the focus of attention of many scholars in the past years (Mytelka and Delapierre 1987, Sharp, 1989, Roscam Abbink/Schakenraad, 1990, 1991, Sandholtz, 1992). Therefore BRITE, BRITE-EURAM and BRITE-EURAM II seem the most appropriate choice to analyse the diffusion impact of a collaborative

programme. Between the start of BRITE in 1985 and the presently operating BRITE-EURAM II, the programme has undergone many changes and mergers with other programmes. Nevertheless, its relatively long history allows us to study the development in time. For this reason I will focus on the most constant part of the programme: support for industrial technologies, thus paying less attention to the materials part and hardly any to the field of aeronautics, research areas which were integrated into the programme in later years.

The same basic questions as in chapter 5 will form the lead in this chapter:

- how has the programme evolved over time in terms of objectives and priority actions?
- what concept of innovation and diffusion can we identify from BRITE documents and actions and has this changed during its development in time?
- has the programme been successful in contributing to diffusion of technologies and best-practice throughout the EC?
- have the levels of conflict as described in chapter 2 constrained or facilitated the programme's operation and objectives?
- what has been the impact of the programme on the position of diffusion policy in the Commission's RTD policy?

Unlike the SPRINT programme, BRITE-EURAM has a research support mission rather than an explicit diffusion or innovation mission. How are we going to decide if the programme makes a contribution to diffusion? It requires answering the question whether the balance of support is in favour of either creating new knowledge from basic research or diffusion of new technologies based on existing knowledge. For the BRITE-EURAM programme this means assessing the balance between support for:

- large research intensive firms versus SMEs without internal R&D facilities;
- high-tech industries versus medium- or low-tech industries;

- basic research versus applied research and development;
- technologies for a specific industry versus technologies with cross-sector applications;
- exclusively technological orientation versus incorporation of elements improving the absorptive capacity.

We have seen in chapter 1 that the first parts of these continua can be associated with either a science push or mission oriented approach to innovation, the second part with diffusion oriented policies. If the balance of the programmes support is in favour of the first mentioned elements of these scales, we can conclude that diffusion is not high on the programme's agenda. If the programme aims at the second elements mentioned, we can conclude that the programme is oriented towards diffusion of technologies and knowledge. As for the assessments of results on the project level, I will confine this study to BRITE, and BRITE-EURAM I since the available information from project synopsis and evaluations reaches up to this stages in the programme. The early EURAM programme will not be discussed in great detail either, since it was entirely focused on fundamental research in the materials sciences (CEC-DG XIII, 1988).

6.2 *The origin of industrial and materials technologies: basic research in the BRITE programme*

Chapter 3 showed that the years 1983 - 1984 were crucial years in which important RTD initiatives were taken. The Commission launched many of its large programmes for science and technology, with ESPRIT as the most ambitious one. It is also in this period that the Commission made plans to launch the programme Basic Research in Industrial Technology for Europe (BRITE).

The BRITE Programme originated in a proposal by the Commission of July 1983, for a multiannual programme on basic technological research and application of new technologies (CEC, 1983c). The proposal, in which the name BRITE does not appear, is set up as an overall action programme for research in industrial technologies. Setting out the aims of the programme, the document states that despite the importance of 'high-tech' industries for the Community, this action programme aims to improve the competitiveness of the other -non high-tech - industries. The means to achieve this is financial support for pre-competitive technological research that lies between fundamental research and product development.

According to the Commission, the reason for Community action in the field of technological R&D is that European industry is dealing with several long term problems:

- research is becoming more and more expensive, especially long term basic research;
- it has been difficult to integrate knowledge produced at universities with knowledge produced in industry;
- national support for R&D helps firms in those particular countries but not the competitiveness of the Community as a whole;
- the main competitors, the US and Japan, both have considerable and well coordinated government support for their industries, paying much more attention to dissemination of the results for exploitation by industries (CEC, 1983c).

The proposal stresses that the research funded under the new programme must be pre-competitive: the results of the research must have equal use for several firms who are each others competitors in the stage of product development and marketing. Here lies an important tension within the design of the programme. On the one hand R&D projects were not to be too near

to market, on the other hand the results of the projects should benefit industry within reasonable time.

The proposal of 1983 finally led to a Council agreement in december 1984 that agreed to the figure of 125 MECU for a period of four years for the contribution to the BRITE programme. The programme is managed by Directorate C (R&TD: Industrial and materials technologies) of DG XII. At this moment it has a staff of approximately 20 people.

An advance notice for participation in BRITE was published in the Official Journal in january 1985, because the Council had not taken an official decision yet (CEC, 1985c). The criteria for project selection were high technical quality, pre-competitive character, innovativeness of research and substantial size. The average size of funded projects was expected to be around 1 MECU. There is no mention of criteria such as exploitation or commercialisation potential. The aim is to increase scientific knowledge in the technical fields. After all, the 'B' in the name of the programme does stand for basic. Other criteria are that a project should be backed by a group of collaborating participants and should have partners from two or more member states and one partner at least being an industrial enterprise. The funding takes place in the form of cost-shared projects, where the Community as a general rule will not contribute more than 50 %. The Commission expressed its intention to attract SMEs as participants, although it was well aware of the fact that the effort of submitting a proposal is mostly too large for a SME.

The Commission stresses the importance of SMEs because they are considered to be well geared to the exploitation of new technologies in the emergence phase. This is due to their flexibility in adopting and marketing of new products. In addition they are expected to have management with dynamic features and acting more swiftly into risk bearing activities. Assuming

that submissions of proposals with a SME as the lead industrial partner will be unlikely, the Commission hopes to attract them either in collaboration with larger firms for which they are supplier, or through trade organisations or collective research associations (CEC, 1983c).

The research areas in BRITE are summed up in a technical annex, first written down in the Commission proposal and subsequently in the advance notice in the Official Journal. The technical annex of the advance notice, was almost the same as the one set out in the initial Commission communication. There are two main headings for research, the first being 'pre-competitive basic technological R&D' in several areas (for instance joining techniques, laser technology for metal shaping, testing methods, CAD/CAM). The second is 'pre-competitive technological R&D including pilot and demonstration projects in new production technologies' (for instance handling of flexible materials, automated sewing units). Whereas in the initial communication this second area is explicitly stated to be for the textile industry, in the technical annex of the advance notice, textile is replaced by the term *flexible material*. It seems the Council found that this explicit reference to a specific industry reminded too much of the sort of industrial policy that national governments at that time were desperate to step out from. The technical content of this subarea however remained the same. A total of 11 main research areas, with 36 subareas are listed as priority area (table 6.1).

The choice of these topics was a quick operation at the start of the programme, making use of written interviews with many industrial research scientists, not however with managers operating in industry (CEC, 1988c:16). We can see that the research areas include mostly manufacturing technologies that have a potential for a wide field of applications across industrial sectors. However there is no mention how these sector wide applications or exploitation of the results are secured.

Table 6.1: Research areas in BRITE programme (1985 to 1988) and distribution of budget after project selection in percentages



Aston University

Content has been removed due to copyright restrictions

Despite the generic technology approach, there is an inclination towards particular industries: the metal, plastics processing, chemical and textile industries are most likely to apply the assigned technical research areas. For many of the specific technical areas the Commission communication points out to government support efforts on these areas in the US and Japan, stressing that the EC is lagging behind. Thus the choice of technology areas is largely inspired by the support activities of Europe's competitors, in an attempt to join the race. In the evaluation of the programme the expert panel states that the chosen basic technology areas represent more than 80 % of technologies used in industry and are therefore essential for competitiveness. "From its investigations, the panel is satisfied that, with a few exceptions, most

of the projects selected for BRITE-I relate to basic technologies, and this emphasis must be maintained for BRITE II" (CEC, 1988c:14).

After the first call for proposals a total of 599 proposals were received by the Commission, involving 1977 participants, on average 3,5 partners per project. Of the total numbers of participants 58 % were industrial firms, 22 % research institutes and 20 % universities. The average cost of each project was about 1,6 MECU. Almost all industrial sectors applied to the programme and "a high percentage showed intersectoral co-operation" (CEC, 1987a). Because the proposals exceeded the available funds by far, only 103 projects were sponsored in the first round of BRITE with 60 % of the participants from industry (of which 30 % were SMEs), 21 % from research institutes and 19 % from universities, the total number of participants being 465. Thus the number of rejected projects was very high. Because of the delays in the decision procedures, the subsequent selection of projects and signing of contracts, the earliest date of work started on any BRITE project was 1st January 1986, more than two and a half years after it was first proposed by the Commission. After the programme had run for one year the Commission attempted to improve the participation of SMEs through an information and assistance campaign and by simplifying the application procedures. According to the Commission, experience had shown that there is a direct relationship between the number of successful proposals and the information efforts undertaken at national level (CEC, 1987a:5).

In 1988 when Brite had finished its first phase in the First Framework Programme, it was evaluated by an evaluation panel, consisting of industrial managers, research scientists, industrial consultants and senior officials (CEC, 1988c). The overall conclusion was that BRITE had made some important achievements, even in its short time of existence. The first one to be mentioned is:

"BRITE is unique in its orientation towards established industry and production technologies, which are the largest employers in Europe. Strategically therefore it occupies an important position in community science and technology policy." (CEC, 1988c:IX)

So whereas most EC programmes serve 'high-tech' industries, BRITE is the only one for mature industries. Industry endorsement at this first phase of the programme was very strong: 67 % of the budget went to industry. In spite of this, the evaluation panel finds that BRITE has too much of a science-push tendency and too little a market-pull approach. The priorities of the programme, the design of proposals and the selection of the projects are being made by scientists and technical staff. Too little industrial and commercial experience is involved in these processes:

"The panel's investigations have exposed examples of weakness in European industry with regard to the management and strategic direction of technical and research activities. As a result, some BRITE projects have clearly been pushed through by research people, not pulled through by a corporate plan i.e. too much "technical push" and not enough "market pull." (CEC, 1988c)

The report also suggest that BRITE should pay more attention to diffusion and technology transfer, without becoming such a programme itself.

"An important but *separate* issue is the need for a stronger and more effective policy in the Commission on technology transfer and the diffusion of industrial innovation." (ibid. p.6, italics PB) It should therefore make its results available through programmes like SPRINT. Dissemination of existing technologies is seen as the major challenge for European industry, "for the full exploitation of existing technology, leaves much to be desired in most European countries." (CEC, 1988c:5)

The evaluation panel clearly considers the diffusion efforts of the Commission and BRITE in particular as insufficient. At the same time they consider this a matter which should not be dealt with by the programme itself.

A further point made by the evaluation panel is that the term 'pre-competitive' research appears to be in conflict with the main thrust of the BRITE programme:

"The panel remains puzzled by the incorporation of the concept of pre-competitively in a research programme whose primary goal is to enhance the competitiveness of European industry. This is a major contradiction which the Commission cannot escape. Some excellent projects were not funded because they were considered too "competitive" by the selection team. Concern about the idea of pre-competitively has also had the effect of pushing some projects upstream so that their industrial interest diminished." (CEC, 1988c:12)²⁴.

Another observation by the evaluation panel is that BRITE is a programme of large contracts and large contractors. Figure 6.1 shows that 44 % of monies went to companies employing more than 5000 people, and 52 % of monies to contracts in excess of 2 MECUS in total. Only 6 % of monies went to contracts under 1 MECU (CEC, 1988c:Annex 3:14-15).

The participation of SMEs with less than 100 employees was not very high in terms of share in the budget: 17 %. However according to EC norms, firms with less than 500 employees qualify as an SME, and these received 31 % of the budget. So despite the information action towards SMEs the programme mainly attracts large companies.

²⁴ The panel points out that in the US Anti-Trust legislation has been altered to the benefit of R&D partnerships, suggesting that the Commission would do the same. "The panel fully realises that there were good legal reasons for this criterion to be written into BRITE. But the law should be the servant of the Community, not its master" (CEC, 1988, page 12).

Figure 6.1: Distribution of BRITE budget by size of contractor



Source: CEC, 1988c.

In February 1988 the Council amended the original decision on BRITE after a proposal from the Commission (Council, 1988, CEC 1987d and 1987e). The main amendments were:

- additions concerning the role of the research programme in the social and economic cohesion: "(...) and that Community action is justified where research contributes *inter alia* to the strengthening of the economic and social cohesion of the Community and the promotion of its overall development";
- allowing partners from non-Community European countries, especially EFTA countries;
- considering research organisations mainly sponsored by industry as industrial partners, and a preference for two industrial partners per project;

- an increase of funds to 185 MECU (instead of the 125 MECU allocated for the programme at its start) for the period 1985 to 1988. This increase of funds was asked for by the Commission in a first review made in 1986. This to avoid a large proportion of proposed projects to be rejected again, expecting even more proposals than in the very first round (Council, 1988).²⁵

Phrases in the original Commission proposal that were not added in the Council decision, were a more far reaching commitment to cohesion and the contribution to employment. Their proposed consideration was:

"Considering that the BRITE programme should pay special attention to decrease the differences in the technological development between the different member states of the Community and when possible to contribute in the creation of employment." (CEC, 1987d and 1987e)

These proposals can be seen as an influence of the Single European Act in which the cohesion matter was put firmer on the agenda by the less favoured countries. On the other hand asking for a contribution to employment was not likely to achieve Council agreement, since it was exactly this type of 'defensive industrial policy' that many nation states had just abolished.

An assessment of the first phase of BRITE in the light of the five continua we presented in the introduction, gives an ambiguous picture:

- despite the aim to attract SMEs to participate in the programme, large firms (> 1000 employees) have received 58 % of the budget. Of the SMEs only technological SMEs have participated;

²⁵ IRDAC even advised to quintuple the resources of the programme and increase the remaining 60 MECU for the second round of BRITE to 300 MECU to have a less high rejection rate.

- BRITE has an orientation towards mature industries, but a lack of exploitation requirements questions the contribution to diffusion in those industries;
- the programme has a strong science push approach; the principle of pre-competitiveness is pushing the research projects up stream, away from more applied projects with potential for commercialisation;
- despite the 'upstream' character of the projects, the emphasis on mature industries and basic manufacturing technologies offers possibilities for cross-sector applications and thus diffusion of technologies. This would be highly improved if there were greater effort within the programme management to assure dissemination of results;
- the concept of improving competitiveness is very much focused on 'introducing a science culture' in industry, thus exclusively research oriented. The programme does have a predominantly industrial rather than academic character in terms of its participants: 67 % of the budget goes to industry, 22 % to non-university research organisations and 11 % to university participants.

In terms of industries and technological areas, BRITE has strong diffusion elements. In terms of clients and business functions involved in the projects, there is a predominantly science push approach.

6.3 *BRITE-EURAM: from basic science to applied industrial research*

In 1988 after the first phase of BRITE had finished, the Commission announced that the programme was to be merged with the materials research programme EURAM into a new BRITE-EURAM programme, anticipating the actions in lines 3.1 and 3.2 of the Framework Programme of 1987 - 1991, falling under the heading 'Modernisation of industrial sectors' (CEC, 1988b). EURAM, a programme on advanced materials, had its start in 1986 for the

period 1986 to 1989. BRITE-EURAM started on January 1st 1989 for a period of four years. Several of the changes made into the programme can be seen as a direct result of the outside evaluation of both programmes. The Commission stated that the merger into a single programme came forward after "... consultations with industrialists and, in particular, the Industrial Research and Development Advisory Committee (IRDAC) and the panels evaluating the first BRITE and EURAM programmes (which underlined) the inseparable links between materials development, product design and manufacturing technology." (CEC, 1988f:3). In 1988 three proposals to launch BRITE-EURAM, were submitted by the Commission (CEC, 1988d, 1988e and 1988f).

The first two proposals were subsequently altered after consultation with the Council. In addition to the objective of enhancing the competitive position of manufacturing industries, the Commission proposed two subsidiary objectives:

"First to encourage transfrontier collaboration within the Community in strategic industrial research between industrial companies and complementary centres of expertise in industry, research organisations, and universities. Second to encourage transfer of technology between sectors and particularly to those sectors, often with a high pre-dominance of SMEs, which are slow in exploiting new technologies to improve their performance." (CEC, 1988e)

This reveals a shift of focus towards the diffusion of existing technologies, with new application possibilities for different industries. The communication used the example of application of information technology developed elsewhere. So with this approach we can see a movement downstream from basic research towards the application of - mainly process - technologies in established industries with a large amount of SMEs. After the merger of BRITE and EURAM the multi-disciplinary character of the programme increased, allowing for 'analytical design' (see Chapter 1), combining mechanical engineering and materials research into the programme. The interrelatedness of innovations as discussed before was given a larger chance through the

combination of different fields of research in the projects. Industrial interest in materials has evolved from traditional domination by materials producers to a cooperative interest of both primary producers and manufacturing firms. Materials such as composite plastics are no longer mass produced but tailored to the specific uses in a variety of manufacturing industries (Groenewegen/Fiebelkorn, 1993:6). Groenewegen and Fiebelkorn see an increase of collaborative efforts between traditional materials producers and the manufacturing industries that apply the materials. The authors have found that in the European collaborative programmes mainly the users of materials were involved in the projects. The user industries have to keep in touch with a wide range of materials and their handling characteristics. Networking through collaborative projects with either other firms or research organisations is a solution to keep up with these increasing knowledge demands. These developments make applied research in this field of greater importance for a wide array of industrial sectors. Diffusion of available knowledge in this research area can have a deep impact on innovation throughout the economic fabric. The borderlines between basic research and applied research in this area have blurred. Introducing more electronics research in the BRITE-EURAM projects, crucial in the field of 'mechatronics' in later years, was a similar development.

The Commission, still having difficulties in attracting SMEs to its programme, introduced an action called 'Feasibility Awards for SMEs'. This was a pilot scheme assisting SMEs to establish the feasibility of a device, process or concept as a means of enhancing their stature in finding a partner in a subsequent call for proposals under the BRITE/EURAM programme. The Commission acknowledged that the investment in human and financial resources needed to prepare for and participate in a major collaborative R&D programme forms a significant impediment for the smaller company. The action is co-financed by the Task Force SME of DG XXIII. SMEs will be supported up to 75 % of costs of research up to a maximum of 25.000 ECU.

So the aim is not to develop a particular technology but to create a basis for an SME to participate in a partnership seeking support for a BRITE-EURAM proposal. Proposals for incremental product or process developments are unlikely to receive Awards according to the guide for applicants that is issued by the Commission.

The Awards are open to independent and technologically based SMEs²⁶ with projects in the same technical areas as the main programme. The Feasibility Awards scheme received only 0.5 % of the programme budget. The first projects under this scheme started August 1989.

Another change compared to the first programme is the definition of priority areas in the technical annex of the proposal. The headings and sub-headings of the research areas are different from the first BRITE programme. In the BRITE-EURAM proposal, the headings for industrial technologies are: 'Design methodology and assurance for products and processes', 'Application of manufacturing technologies' and 'Technologies for manufacturing processes'. The materials related subarea is named 'Advanced materials technologies'. This shows a much more broad approach to modernising manufacturing, and aiming at a wider set of industries (CEC, 1988f). The textile industry, given a large emphasis in the initial BRITE programme, is now hardly represented in the priority areas. Instead of a classification in terms of specific technologies in the former annex of BRITE (such as laser, membrane technology), in the new annex the priority areas are defined in terms of their function in industry. There seems to be less explicit concern with pre-competitiveness. In the advance notice for participation the Commission says that most of the funds will be for 'Industrial Applied Research', which indicates they want to operate less upstream than the original Basic research approach. From the start of BRITE-EURAM, the

²⁶ An SME is defined as having less than 500 employees and capitalization (net fixed asset value) of less than 75 MECU.

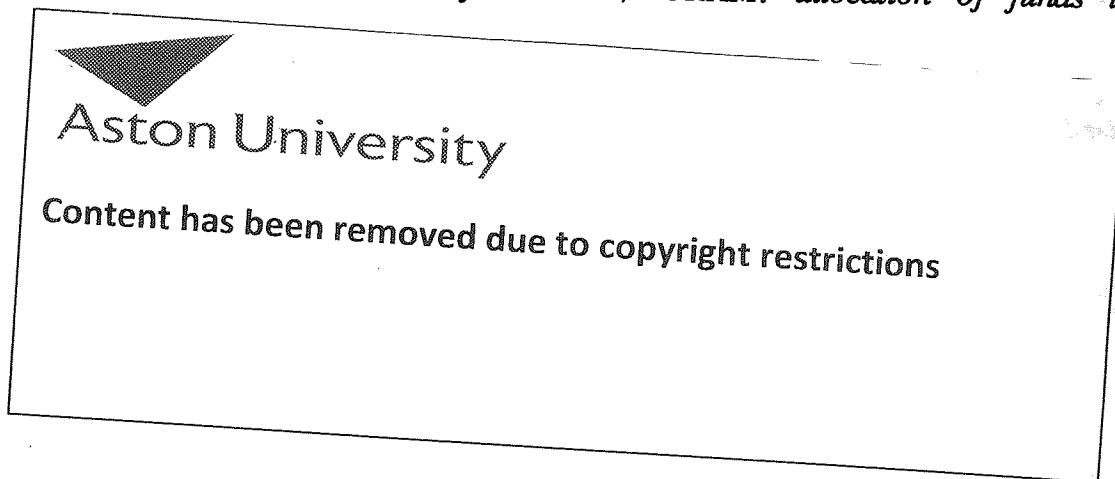
proposals for new projects formally have to take into account the economic impact of the project.

It took the Council up to March 1989, eight months after the proposal, to reach a final decision on BRITE-EURAM (Council, 1989). There were several changes to the Commission proposal of July 1988:

- Whereas the Commission asked for 439,5 MECU, the Council allocated 499,5 MECU to the programme mainly as a result of adding the research area of aeronautics to the programme.
- The Council decided to integrate research relating to aeronautics into the new programme, with the objective to strengthen the technological competitiveness of European aeronautical industry. According to a BRITE-EURAM official this area was forced into the programme, because they did not know where else to leave this sub-programme, too small to exist by itself. Evaluations of aeronautics research is usually conducted separately from the BRITE-EURAM activities.
- The Commission, setting the criteria for the programme evaluation, proposed that the evaluation should determine whether the projects have contributed to the *harmonization* of the Community by reducing the technical barriers to trade. This criterion was replaced in the Council Decision which referred to all selection criteria set out in the Framework Programme, "which include that of contributing to the strengthening of the economic and social cohesion of the Community" (Council, 1989a).
- The rules for implementation were changed so that in cases of universities and research institutes carrying out projects the Community may bear up to 100 % of the additional expenditure involved.

The Council (1989a) made an indicative internal allocation of funds over the different programme areas:

Table 6.2: *Priority areas for BRITE/EURAM: allocation of funds in*



Between 7 % and 10 % of the budget shall be made available for fundamental research in the above areas "... where industrial progress is impeded by gaps in basic scientific knowledge" (Council 1989a). In this area there is no need for an industrial partner, an industrial endorsement by nominated individuals from industry is sufficient. So the other 80 % to 90 % of the budget is for Applied Research.

An indication for a shift in approach compared to the previous years are the criteria for selection, which were described in the information packages for the call for proposals (CEC -DG XII, 1989). In the first call of proposals under BRITE-EURAM, a distinction is made between different types of research projects for which different criteria of selection are used. Industrial applied research projects, which accounts for 90 % of the budget, would receive a financial contribution of not more than 50 % of the eligible project costs. In these projects at least 2 industrial participants have to collaborate, the potential for exploitation had to be shown and subsequent development expected. In the application forms hardly any space was reserved to explain the economic benefits and exploitation routes of the project.

DG XII had an outside study carried out by a consultancy in early 1990 with the intention of hearing the contractors' views on the functioning of the programme (CEC, 1990c).

In general, the views on the achievements of the programme were very positive. 80 % of the participants stated that the programme had enabled them to deepen the scope of their R&D in areas strategic to them. Over 95 % expected to reap the commercial benefits of their project within the five years following its termination. According to the report : "A commercial exploitation of the results is foreseen within 5 years, which confirms the "applied research" orientation of the BRITE-EURAM programme" (ibid., Annex 2:43). The negative views on the programme all related to the administrative procedures of making a proposal, and the long time between the submission of a proposal and the actual contract to be signed. Again it stated that the access to the programme is difficult for SMEs, especially as prime partners.

In 1992 the Commission published an evaluation study of finished projects in the BRITE, EURAM and BRITE-EURAM I phases (CEC-DG XII, 1992b). This evaluation was not only commissioned on behalf of the BRITE-EURAM programme (DG XII) but also by VALUE (DG XIII). It was particularly focused on the industrial and commercial exploitation potential of the projects under review. Therefore for the study of the diffusion performance this evaluation is an important source of information. The evaluation covered 75 projects finishing in 1990 and 132 finishing in 1991.

There seems to be a strange contradiction in the conclusions drawn from the surveys. Three quarters of the projects present an economic potential according to the evaluation. "There is however a discrepancy between the share of projects with an economic potential and that of projects with an exploitation capability: the will and capability to effectively exploit the economic potential is strong in only 37 % of the projects" (ibid:9). The economic potential of the results was assessed by four indicators: the exploitation potential, diffusion, risks of a technical, manufacturing and

commercial nature and market-productivity gains. This raises strong doubts on the economic potential that the evaluation has found. If the projects participants are not willing to exploit the results of a research project in which they have spent a considerable amount of money, you can hardly speak of economic potential of the project. One of the weaknesses of the management of the CEC revealed by the evaluation was their contribution to the exploitation of the results (ibid.:94). Apparently this is an activity the CEC officials are not used to deal with. This is where VALUE comes into the picture: half of the projects finished in BRITE/EURAM were considered to be candidates for an extended support to facilitate exploitation. With the VALUE support, firms can receive further funding to proceed in the exploitation route. The funds are acquired in competition with other firms from other programmes, so there is no guarantee for a follow up.

Lack of strategic commitment was presented as the main explanation of this discrepancy: "Considering the transfer of the achieved RTD results to their effective exploitation, two variables play a key role: the presence in the partnership of interested industrial end-users and the will and capability of the partners to exploit the results. This last variable is directly influenced by the commitment and motivation of the partners" (CEC-DG XII, 1992b:11). One of the recommendations from the report was that R&D could become more exploitation-oriented. "This requires the strategic interest of the projects for the partners, their commitment and their exploitation capability to be monitored and checked during the projects" (ibid.:12). This seems a difficult task to be performed by EC officials. In addition the survey also showed a strategic interest for the partners in 61 % of the projects. But commitment requires more, it is defined as a measurement of the involvement in the project by the non-R&D departments of all the industrial partners. And on this criterium the score was much lower: only 44 % of the projects showed a strong commitment by some partners, or a substantial commitment by all. As said before only 37 % of the project partners demonstrated a strong interest

in the actual use or the possibility of exploiting the project results (ibid.). The report recommended that it is important to increase the partners' future commitment.

Success in terms of exploitation success for the project participants, particularly if they are counted by patents derived from the projects, are not appropriate indicators for the impact on diffusion. The commercial value could be very limited. The report measured a diffusion indicator, depending on the number of potential uses of the results: 58 % of the project results had two or more potential different users, 38 % of the results were applicable for three or more users in a minimum of three separate sectors. If this is the number of actual users of the project results than we could conclude that the diffusion impact is disappointing.

These are clear indications of a dominant linear approach in the collaborative projects that are defined and selected solely on the basis of R&D criteria. The integrative approach showed the importance of the early involvement of all business functions and of user requirements. There are some factors indicating that the chances for a more diffusion oriented approach are increasing in the course of time.

- Separate from the exploitation capability, which depends largely on the commitment to the project, the evaluation study measures the exploitation potential of projects: 40 % has a strong, 34 % a medium and 26 % a weak exploitation potential (CEC, 1992b).
- The market-productivity gains potential, a quantified translation of the exploitation potential showed that three-quarters of projects show some market potential. A majority of the projects (56 %) were 3 years or less from the market, and 25 % of them were only one year or less away (ibid.:84). There was a discrepancy between the research areas: projects in the industrial technology fields ('design and manufacturing' and 'quality control and assurance') were much closer to the market than the projects in the materials research areas (ibid:92).

- The evaluators found a learning or generation effect between the first and the second call for proposals of BRITE. Therefore the later projects performed better on the strategic interest of the project for the partners, the market timing (closer to the market) and impact on the SME partners. So apparently there has been a shift from basic to more applied research.
- Although this evaluation was published in 1992, it was based on projects finished in 1990 and 1991. These were projects that started in the earliest phases of BRITE and BRITE-EURAM. Selection procedures had a different character: much more science-led, less industrial partners required, no exploitation routes in the proposals. In BRITE-EURAM I indications of possible exploitation were required in the proposals. Those projects will finish in later years.

BRITE-EURAM is however, still a programme for the larger companies. The average budget of a project was about 1.2 MECU. "In 58 % of the projects evaluated, large companies are the dominant profile in the partnership. For the SMEs the corresponding percentage is 29 %. Nevertheless some SMEs were involved in partnerships with a large company holding the dominant position. 53 % of the projects had no SME involvement (CEC-DG XII, 1992b:74).

The contribution of the projects to the innovation potential of SMEs was strong in 47 % of the remaining projects, in 15 % the contribution was negligible or non-existent, in 38 % it was medium (ibid.:78).

A BRITE-EURAM evaluation of 1993 did not indicate the share in the budget, only the number of participants: almost 23 % of total participants are SMEs and 39 % of industrial partners are SMEs. The share of SMEs as project leader was much smaller: almost 21 % (CEC-DG XIII, 1993c:10). An additional study on the economic effects of the programme, an annex to the evaluation study, showed that the larger firms were much more efficient at generating both direct and indirect economic effects from their research projects. The only performing SMEs in the industrials sectors covered by the

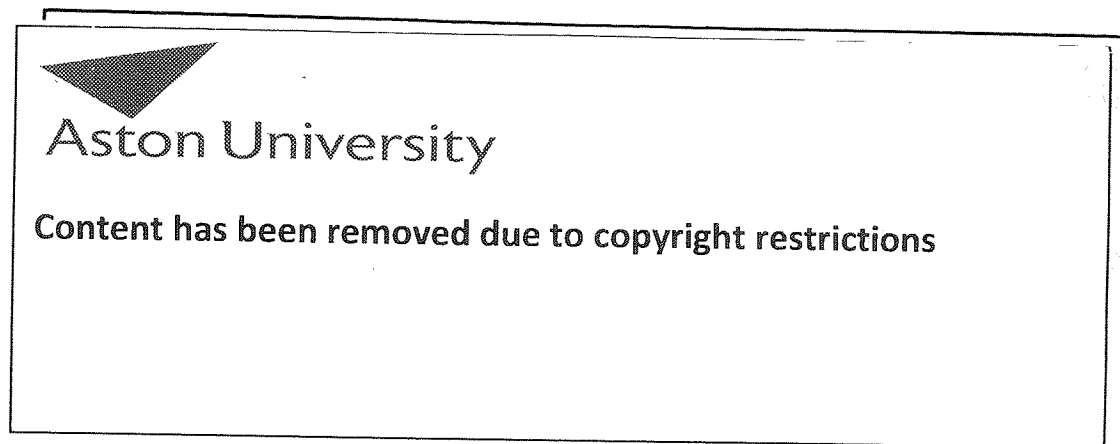
BRITE-EURAM programme, were 'high-tech' firms which hold a technological and market monopoly in a niche. Low and medium-tech SMEs were hardly present as participants (European Commission, 1994:23-25). A 1994 document, in which the Commission synthesises the results of these evaluations and draws conclusions for potential participants, stated that SMEs who wish to participate should be high-technology in nature, experienced in international collaboration and markets and 'be of minimum size'. Other SMEs were referred to participate in the CRAFT scheme, launched in 1991 (ibid.).

6.4 *BRITE-EURAM II: stamping out the linear approach*

In April 1990 the Council adopted the Third Framework Programme and although BRITE-EURAM I was still running, with this new Framework Programme also a new BRITE-EURAM II programme was announced (CEC, 1990a and Council 1990). The programme is given a new name: *Industrial & Materials Technologies (IMT)*. This official name is given by the Council Decision and reflects the aims of the programme. The BRITE-EURAM II is the unofficial name, given to it because of its established reputation in European industry. However Commission officials stress that BRITE-EURAM should be considered as a 'brand-name', the letters of the acronym do not stand for their former denotation. It took the Council until september 1991 to approve the programme and allocate a budget of 663,3 MECU for the period 1991 to 31 December 1994 (Council 1991a and b).

Figure 6.2 summarises the history of the programme from its very start up to BRITE-EURAM II.

Figure 6.2: History of BRITE-EURAM



The problem of the disappointing involvement of SMEs was to be overcome by a new accompanying sub-programme in BRITE-EURAM II: CRAFT. This new type of shared-cost research enables groups of enterprises without research facilities to contract outside research institutes, universities or enterprises to carry out research and development on their behalf. A proposed project needs to have a 'bottom-up' approach, reflecting the needs of the SMEs and affecting a number of companies rather than an individual company²⁷. The CRAFT scheme received a total budget of 57 MECU.

²⁷ The definition of a SME has changed, being a company which:

- has less than 500 employees
- has a net annual turnover of less than 38 MECU
- is not more than one third owned by a parent company or any other organisation larger than an SME, although larger shareholdings held by investors such as banks or venture capital firms are permitted.

In the main IMT programme the technical priority areas fall under three headings, each of them with several sub-headings:

1. Materials/Raw materials, allocated 47 % of total budget;
2. Design and Manufacturing, allocated 45 % of total budget;
3. Aeronautics Research, allocated 8 % of total budget.

Although the broad areas of research are more or less the same, the IMT programme has a different emphasis and objectives, which reveal an apparent shift in the perception of innovation and the role the programme can play in this process. The programme's stated objectives are:

- to increase the competitiveness of European producer and user industries;
- to strengthen European economic and social cohesion;
- to promote the scientific, technological and economic integration of European industry (CEC-1990c and 1991b).


Especially the first objective reflects that the exploitation side of the supported projects is receiving much more emphasis. This is confirmed by the strategic aims that complement the general objectives of the programme:

- to increase the application of advanced technologies by small and medium sized enterprises;
- to increase the involvement of manufacturing SMEs in European RTD through developing links with other enterprises and promote a better management of their resources;
- to reinforce and diversify the training of research workers and engineers for modern European industry;
- to give full consideration to the social, human and environmental impact of advanced technologies;
- to ensure an appropriate dissemination and exploitation of results, especially for development of standards and user specifications (ibid.).

This shows a much broader approach towards innovation than the previous more science led views which dominated BRITE and BRITE-EURAM I. In

this broader view not only the science led creation of technologies are the sole means to achieve innovation, but also the implementation of new technologies (organisational and managerial aspects) and the institutional context (user - producer relations for instance) receive attention. The emphasis on established industries has disappeared from the agenda, at least in explicit terms, and replaced for the very general term 'user and producer industries'. These criteria are translated into the character of project through the selection panels who receive instructions on what basis to select projects. The Information package published with the First call for proposals (1991) and the Second (1992) state clearly that proposers should state the expected scientific, technical and economic benefit from the project (CEC-DG XII 1991 and 1992a). The pre-competitiveness principle however still applies. The package has a lists which gives marks for the selection criteria of proposals in four categories:

Table 6.3: The weight of selection criteria for BRITE-EURAM projects

	Aston University
Content has been removed for copyright reasons	

Proposals should have a strong score on all these categories. The results of the projects in terms of economic and social benefits have a an important share deciding on the chances to be selected. BRITE-EURAM officials ensured that this is not only a requirement in the selection procedure, also from the mid-term review of projects the exploitation routes should be set into motion. The BRITE-EURAM officials managing the projects monitor if this happens. Also

after the end-report it is expected that the participants take up the exploitation. The interpretation of exploitation is not entirely clear. It also includes filing patents and arranging the property rights among the participants in a project.

Do the results of the projects confirm this change of perspective? The problem is that there is a time lag between the evaluation of finished projects and the programmes in operation. The results of the evaluations reflect the projects selected in much earlier phases of the programme. We have to rely on the later evaluations.

While BRITE-EURAM II was already in operation, the Commission had another, this time final, evaluation made of the BRITE-EURAM I programme (CEC-DG XIII, 1993c). The results and recommendations however reflect much of the issues and developments that effect BRITE-EURAM II.

Most striking is that the evaluation panel clearly distinguishes a shift to 'near-market' research which poses a problem for the programme:

"BRITE-EURAM has been changed, in accordance with the Single European Act (which implied more emphasis on cohesion and SMEs, PB) and the recommendations of previous evaluation reports, further towards 'near-market' research. This change together with the sustained promotional effort has generated a strong increase in the number of applications." (CEC-DG XIII, 1993c:13)

The panel foresees a crisis in the management of the programme if this would continue, reinforced by the enlargement of the Community. Some crucial observations are made on the causes of an imbalance of the programmes' activities. The report states that this is due to a gradual change in focus of the Programme's mandate.

"The Programme may be trying to meet simultaneously, a number of objectives which, although individually sound, are to some extent incompatible. For example:

- the Programme is aimed at fostering 'pre-competitive research' but faces understandable political pressure to show immediate economic benefits.
- the Programme is supporting SME projects to an increasing extent, but should not be too close to the market which is, however, of primary interest to the majority of SMEs.
- the Programme is supposed to contribute towards European cohesion, yet it has to accommodate this with the mandate of selecting projects on technical and scientific merit alone.
- even with growing support for SMEs, the Programme can make only a very tiny contribution to developing the technological skills of European SMEs. The 436 participants in BRITE-EURAM represent about 0.025 % of an estimated total population of 1.7 million SMEs.
- there appears to be mounting pressure from some Member States for 'juste retour' (the concept where receipt of funds for project support in a Member country matches their national contribution to the programme). Even tacit acceptance of such a concept by the Community could generate severe conflicts in the selection process and would inevitably undermine the quality of future research projects." (CEC-DG XIII, 1993c:13-14)

The report suggests that the programme should move away from 'near-market' research again and back to pre-competitive research. The panel recommends that increased emphasis be given to generic technologies and to strategic as opposed to purely applied research. A stricter application of pre-competitiveness criteria would also reduce the number of applications to the programme. SMEs should be served by a separate programme, according to the panel. Whereas the results from the 1992 evaluation do not confirm this picture (a lack of exploitation potential was still a main point of criticism) a 1994 synthesis of both 1992 and 1993 studies, adds some figures that reveal the shift to 'near-market' research even better. The majority of the projects participants (almost 40 %), taken from a sample of the 1993 evaluation study, are involved in applied research, directly devoted to an industrial problem. Another 35 % of the participants were working even more downstream of applied research: 24 % in development, 14 % in adapting production processes and almost 3 % in quality control. None of the participants claimed they were engaged in basic research.

Another indicator of the scientific or rather commercial contents of the research projects is their time to market: the majority of projects is 2-3 three years from market launch. Of the projects evaluated in 1993 two thirds are 2-3 years from market. Almost 30 % is within a year from market. In the words of the Commission:

"The EC's early research programmes (mid 1980s) were oriented towards scientific and technical achievements. The programmes of the 1990s, however, focus more on 'market-oriented' or 'application-oriented' research. Does this mean that EC programmes are losing their pre-competitive nature? No. Being pre-competitive does not preclude a research project from developing competitive applications. It does mean, however, that when a project starts, the technical risk must be high. So high, in fact, that basic research must be carried out before applications can be envisaged." (European Commission, 1994)

In EC terms however, BRITE-EURAM is a very successful programme, well known with enterprises in manufacturing industries. Call for tenders usually attract a multiple of possibly selected projects. In the fourth Framework Programme *Industrial technologies and materials*, the official name of the programme, is to be awarded an 1.67 billion Ecu budget for the 1994-1998 period.

6.5 *Constraining and facilitating factors in the Community policy context*

6.5.1 Competence in industrial policy and pre-competitiveness

We have seen that the strictness of the pre-competitive criteria have relaxed together with its interpretation. In the first BRITE programme, the science-push approach and the strictness of the pre-competitiveness principles were criticised in the evaluation. The 1988 evaluation was very explicit to state these findings (CEC, 1988c).

Over the years there is an apparent shift from the science oriented focus to a more industrial application focus. There are several indicators that back this observation as we have seen:

- the share of industrial participation is one indicator. The evaluation reports do not provide comparable information on this. In the 1988 evaluation the share of the budget going to industrial partners was 67 %.
- evaluations report the gradual increase of exploitation capabilities and strategic interest, and a shortening of time to market, all of which increase with more downstream and less pre-competitive orientation. They point in a similar direction: in the design of the collaboration project the strategic possibilities for the results to become commercial products has been taken into account.
- in the selection process the Commission and its expert panels have authorised and encouraged such a shift.

This apparent shift means that the pre-competitiveness principle has lost political weight in favour of more direct forms of action to facilitate industrial competitiveness. Groenewegen and Fiebelkorn (1993:12) make a similar observation when investigating the EC's material research: "Moreover the focus has changed from support of the science and technology basis towards fostering innovative capabilities. This necessarily has led to a weakening of the criterion of pre-competitive character of projects".

Commission officials do not attribute this to changing power conflict within the Commission, in which competition policy has lost position in favour of advocates of larger Commission competence in industrial policy areas. Interviewees state that it is the result of the seriousness of the economic crisis and increase of global competition in which European firms have to fight for their market positions. The growing criticism on the lack of effectiveness of R&D expenditures must also have contributed to the political pressure to show more immediate results from the projects.

6.5.2 The contribution to social and economic cohesion

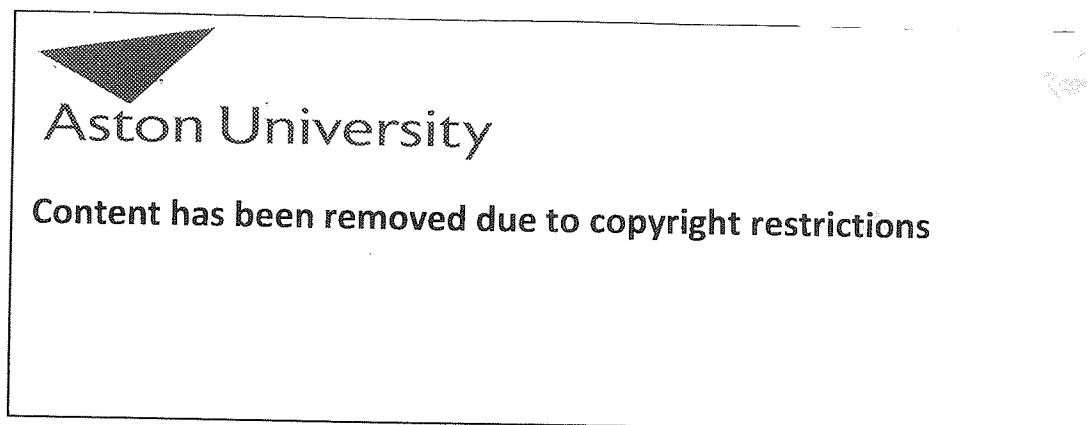
A major point of criticism towards the core R&D programmes is that in the economic logic of these support mechanisms, there is a bias in favour of participants from the most developed parts of the Community. Basic or pre-competitive research is performed by companies with a certain research intensity or by research organisations such as universities or public research centres in touch with industrial research demands. These programmes are therefore less suited for industries with low or medium research intensity and for SMEs who cannot afford to participate in large-scale research projects. As we have seen above, BRITE and BRITE-EURAM have objectives to take account of both traditional sectors and SMEs. Given the sectoral patterns of specialisation, this would also imply that the barriers for firms from less favoured countries would be much lower than in programmes focused on the high-tech industries. None of the evaluation reports have criticised the programme for not contributing to cohesion. On the contrary the networking effects of pan-European collaboration are considered to justify the programme on the Community level (CEC-DG XIII, 1993c).

Has this stated objective been met if we look at the available data on the participants?

In the very first years of the programme the figures seem to indicate the reverse. In the first evaluation conducted by an expert panel the statistics show an unbalanced picture (CEC, 1988c).

All member States participated in the BRITE budget. Spain and Portugal, because of their late entrance in the EC, joined only in the second call. Figure 6.3 shows the distribution over the countries.

Figure 6.3: *Distribution of budget by country*



MEMBER STATE

- * Spain and Portugal could participate only in the second call

Three countries, France, UK and Germany dominate, with a total share of 64 % of the budget. Relative to national GDP, the smaller and less developed countries secured a higher share of the budget than the larger developed member states. But the ratio of industrial organisations committed versus non-industrial was larger for the larger countries. According to the evaluation BRITE has worked well for the cohesion of Europe: the smaller and technically less advanced member states have performed well in BRITE, relatively they have gained a greater share of the budget than the larger and more developed Member States. Countries with a high national research intensity, France, UK, Germany and Netherlands tend to receive a proportionally lower share of BRITE than countries with a lower research intensity. Later evaluations do not reveal the distribution of budgets, rather

the number of participants and project leaders from each country. Apparently the Commission wants to avoid a discussion of 'just retour'.

Concerning the transnational collaboration, the 1988 evaluation report states that most projects have been based on bilateral relationships which already existed, although BRITE has helped to strengthen the networks. All countries are involved in these networks, although the larger ones have formed the most links. The strongest linkages (measured by the number of collaborations) are between the larger countries - UK, Germany and France. The links in terms of the type of partnerships established show that the main number of linkages are between large companies, with about half that number between SMEs. Table 6.4, from a CREST evaluation report of the Second Framework Programme, quantifies the number of links in the BRITE-EURAM programme.

This does not directly reveal information on the geographical distribution of the linkages. However, the dominance of links between the large companies could indicate a bias towards the 'core' countries, since they have a relatively large presence of these types of organisations. Striking is that the SME/research links (1099) are more numerous than the large companies/research links (931). The large companies probably rely on their own internal R&D departments. The induced linkages have been more firm-to-research links than firm-to-firm links. Studies have shown that firm-to-firm links are very crucial in the learning processes of innovative firms and SMEs in particular (Teece, 1986, Lundvall, 1992).

Table 6.4: Links established between participants by organisation type in BRITE-EURAM



Aston University

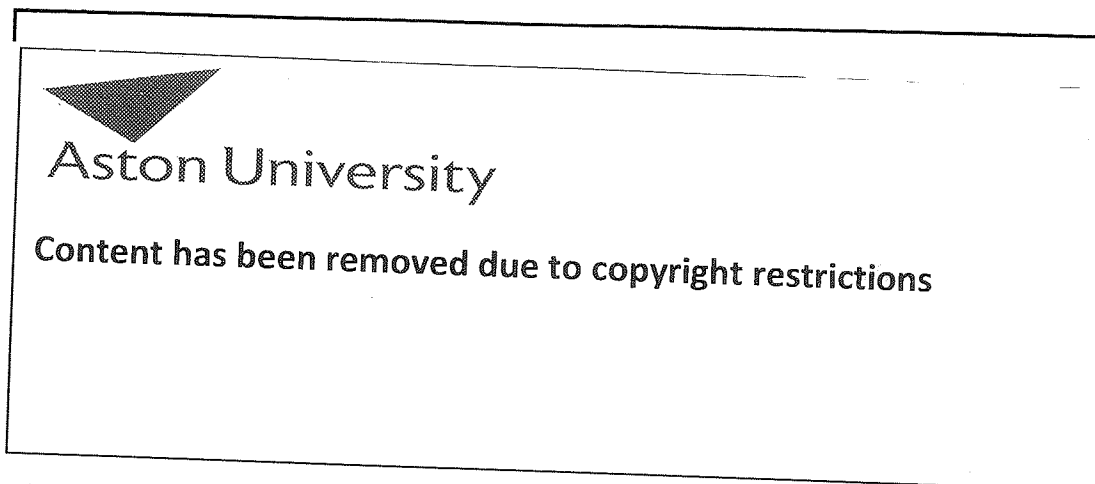
Content has been removed due to copyright restrictions

Another source to identify the geographical distribution of participants and their links are the 'Project Synopsis' books, indicating all projects and their participants, published by BRITE-EURAM (CEC-DG XIII, 1990b, 1991a and 1993b). It is interesting to see where the project leaders come from and which partners they choose²⁸. The origin of project leaders per country gives a first indication of the geographical spread of the participation.

This figure shows that France is far ahead in number of project leaders, closely followed by the UK. Remarkable is the relatively modest number of German project leaders compared to the two other large countries.

²⁸ Every supported project has a prime partner who functions as coordinator. Each project needs participants from at least two member states, but more partners can be added from the own country of the prime partner.

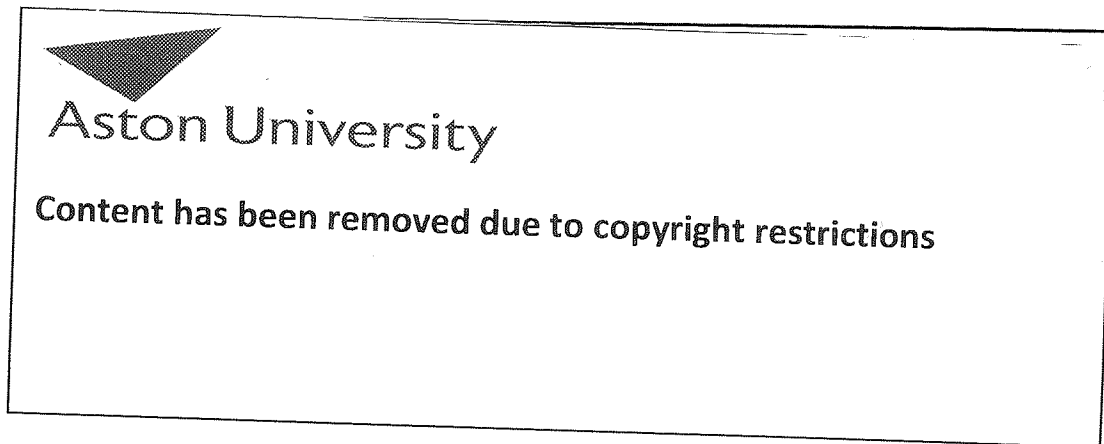
Figure 6.4: *Origin of project leaders*



Source: BRITE/EURAM synopsis 1989-1990, CEC DG XII 1990b

In the following figure (figure 6.5) we see the three most frequent origins of the partners chosen by project leaders from each country. For instance for every project with a Belgian project leader, 28,6 percent of the chosen partners are from Belgium as well, 19 percent are from France and 15.9 percent from Germany. The remaining 36,5 percent are from the other Community countries. We can see that, - with exception of Luxembourg -, in all cases the project leaders seek collaboration with a partner from their own country, and for Belgium, Germany, Denmark, Spain, France, Italy, Portugal and the UK, partners from their own country are in the majority.

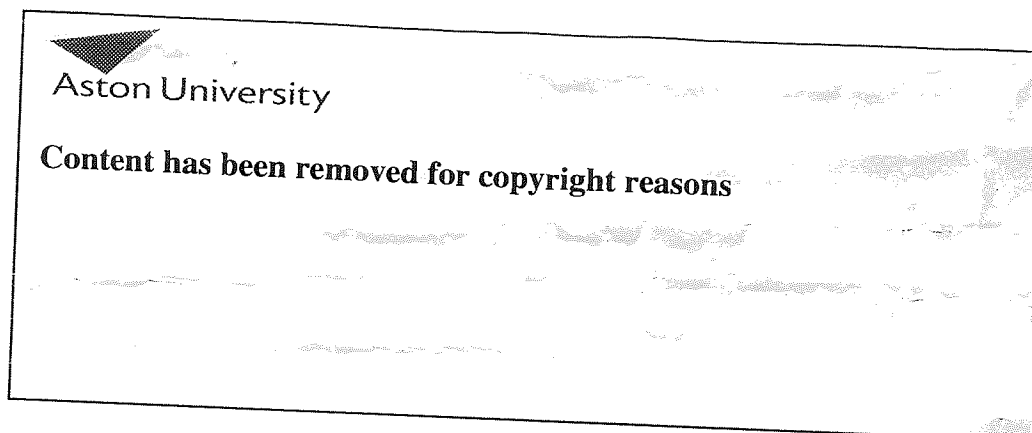
Figure 6.5: Most chosen origin by project leaders



Source: compilation from CEC-DG XIII 1990b.

For the three 'strong' countries in the EC, France, Germany and the UK the three most chosen origins of partners come from amongst the three of them. German project leaders chose 26.9 % German partners, 19 % French partners and 17.8 % UK partners. French project leaders chose 32.3 % of their partners in France, 17.8 % in the UK and 14.3 % in Germany. And finally the UK chose for 27.8 % a UK partner, for 19.9 % a German and 14.9 % for a French partner.

Table 6.5: Choice of partners in France, UK and Germany as share of all partner links. BRITE-EURAM projects up to 1991



These preferences show a strong 'core-orientated' direction of collaboration. For most countries, French, German and UK partners are the most favourite foreign partners, with the only exception being Belgian partners sought by Irish and Luxembourg project leaders and Danish partners chosen by Greek project leaders²⁹. This confirms the earlier findings by the evaluation panel of the first BRITE programme.

The final evaluation of the BRITE-EURAM programme, published in 1993 confirms these figures. The following figure gives the absolute number of participants and project leaders per country (CEC, DG XIII, 1993c). Again we see a strong bias in favour of the 'big three', both in number of participants and in project leaders.

²⁹ Of course the meaning of this type of analyses all depends on the importance of the element of choice for the project leaders. A prime partner does not necessarily take the initiative in choosing all of the partners. It could be that the prime partner in a project is appointed to be project leader by other partners.

Figure 6.6: *Number of participants and project leaders per country in BRITE-EURAM I*



Source: CEC-DG XIII, 1993

In addition, the character of the participants from less favoured regions deviates from those of the other countries. The evaluation report phrases it as follows:

"A delicate issue, however, is the inclusion of institutes and companies from the weaker regions and countries of the Community. Participation, of industrial companies from the Less Favoured Regions (LFR) is relatively poor and the examination of the projects indicates that in many cases the participants comprise research institutes or local branches of foreign industrial companies." (CEC-DG XIII, 1993c:93)

This gives a picture of fortified 'islands of academic excellence', in the less favoured countries, with hardly any linkages with the industrial actors in the immediate environment. The lack of SME participants from more traditional sectors as established above reinforces this industrial bias.

Looking at the diffusion impact of BRITE-EURAM in geographical terms: the effects are not similar for each Member State and region. The linkages and projects leadership have a severe bias towards the 'core' countries of Europe. The industrial impact in the LFCs is less than in the other countries, due to the mainly academic participation.

6.6 Conclusions: BRITE-EURAM's contribution to diffusion

Starting in the mid 1980s BRITE was clearly a science oriented programme, with the objective to support basic research of a medium-long range. It fitted very well in the linear model approach where research is the major source of innovation. However many elements in the set up of the programme gave it a large diffusion oriented potential. BRITE-EURAM shifted its character and moved to more 'near-market' research. This was the result of fierce criticism in the first evaluation report, a growing awareness of the importance of exploitation for the competitiveness of European firms, political pressure to show economic benefits from the programme and finally more pressure to increase SME involvement. The first call for proposals in 1989 did not yet put much emphasis on clear market potential in an early stage of the project. Exploitation in terms of patents and published research results could be followed up autonomously by the firm or with help of the VALUE programme. Diffusion was a concern of the last stages of the project, possibly years after it had finished. From the second call for proposals market potential became a prerequisite in the selection of proposals, thus forcing participants to take this into account from the very start of the project. It seems that this has caused the scale to tip in the other direction. Emphasis on clear economic benefit in the short term has led the programme to support incrementalism. The objectives of the programme are judged by the direct benefits of the participants, and much less on the economic impact their research projects could have on other firms, sectors or even industries. One

has lost sight of the diffusion impact of the programme. Given the large population of firms in the Community that could apply for BRITE-EURAM support, the economic impact of direct financial support to a consortium with two industrial partners is bound to be limited if incremental innovations with low diffusion characteristics are the result. This could still be an important boost of competitiveness to the participating firms. The issue of the appropriate level of policy is at stake: national and regional initiatives would have a much larger penetration in the industrial community. Therefore the 1993 evaluation panel's recommendation to concentrate on strategic and generic technologies, that have a wide cross-sector impact, could improve the Commission's role as catalyst of innovation.

If we look at the continua presented in the introduction of this chapter, we can now assess the extent of the diffusion character of BRITE-EURAM.

Large firms versus SMEs; The first phase of the programme showed a severe bias in favour of large firms, in particular those above 5000 employees. Later evaluations do not give similar data on shares of budgets. Judging from the share of participants and involvement of SMEs in the partnerships, the situation has improved but the programme still does not perform well enough. In addition, only high-tech SMEs with a strong position in a market or technology niche and international experience are successful in the projects. The launch of Feasibility Studies and the CRAFT sub-programme shows that the BRITE-EURAM service aims to tackle the problem. However as said before the limited budget questions the impact of both initiatives.

High-tech versus medium and low-tech industries; The evaluation reports hardly reveal information as to the sectoral origin of its participants. In addition this does not necessarily reflect the technological contents of the particular projects carried out under the BRITE or BRITE-EURAM programmes. For example a multinational company like Philips, which has often participated in

the programme, is engaged in 'high-tech' developments in the semi-conductor industry as well as 'low-tech' activities in lighting systems. This indicator, often used in studies of diffusion, has not helped much to decide on the diffusion orientation in the case of BRITE-EURAM.

Basic research versus applied research; The developments from BRITE to BRITE-EURAM II revealed the shift from basic research to applied research. We have seen that pre-competitiveness was an important constraint in the first years of the programme's operation, which influenced the selection of projects. This led to an inclination for research that did not have clear market potential. We could see in the previous paragraphs that the development has led the programme to move to 'near-market' in such an extent that the diffusion impact is not optimal. This learns us that for diffusion support to have an impact on the meso and macro level, more is required than financing individual projects in the downstream phases of the innovation process.

Specific industries versus cross-sector applications; The first BRITE programme had a clear focus on specific industries in the consolidation and maturity phase, such as metal working, plastic processing and textile. BRITE-EURAM research areas are more defined around general 'enabling' technologies, with a wide range of applications for manufacturing industries. The fact that projects are moving too 'near to market', has led to a decrease in strategic cross-sector impact. In addition, the induced linkages have been more firm-to-research links than firm-to-firm links. However, compared to most other EC R&D programmes, BRITE-EURAM reaches a much broader industrial and research spectrum.

Technology-dominated or absorptive capacity orientation; We have distinguished between direct effects of participation (technical achievements, economic benefits) and indirect effects. The latter relates more to the non-technological aspects of performing in collaborative research projects. The evaluations showed that the programme has generated learning effects for its participants:

organisational learning related to work planning, management of co-operation and an increased international outlook. Firms are responsible for the exploitation of projects and in some cases additional support from VALUE can be obtained, such as advice for marketing. This is an improvement but reveals a linear approach to innovation: after the research projects have finished, the participants will start to worry about their commercial application. We have seen in chapter 1 that the innovation process cannot be cut up into separate sequential phases. An early involvement of user requirements, and marketing results increases the probability of commercial success. We have seen that early involvement of the 'exploitation routes' is included in the most recent calls for proposals. The attention for the non-technological aspects of innovation has improved in the development of the programme. However the absorptive capacity on a more macro level is not an objective of the programme: it is geared to cause effects for the participants, the producers of new technologies, and much less to the effect on the innovative capacity of industries or sectors. As we have stated above, losing sight of the strategic importance of certain technologies, decreases its diffusion impact on the user side.

To summarize the findings of this case, BRITE-EURAM has made a contribution to diffusion in the sense that it has supported applied research projects in a wide number of industries. The traditional linear model was dominant in the BRITE programme since research, and particularly pre-competitive research was the only business function supported through the programme. In the later phases of BRITE/EURAM I this pre-competitiveness criterion is relaxed, which caused a shift to 'near-market' research, where specific industrial problems were tackled by means of applied research or design. The criticism that followed from this change is a large emphasis on direct economic benefits from the projects, and consequently a loss of sight on the wider diffusion impact of the results. In other words the strategic and generic character of the projects became less important.

Explanations for this shift were:

- the political pressure to show results in terms of cost-effectiveness of the programme;
- pressure to involve more SMEs in the programme, which have an inclination towards 'near market' development activities rather than generic research;
- a general shift in the awareness that exploitation is equally important for European industries as is the creation of new knowledge, triggered by the seriousness of economic problems in the late 1980s;
- an increased Commission competence in industrial policy as described in chapter 2.

From 1989 onwards, the principle of economic and social cohesion has been incorporated in the objectives. However we have pointed to the 'core-orientation' of the links that have been formed in the projects.

It seems that BRITE/EURAM II has moved away from a clear domination of the linear approach in favour of the incorporation of more elements of the integrative approach. There are still some elements missing: the programme concentrates on the supply side of new technologies. Although projects have more chance to be selected if potential users are part of the consortium, the potential diffusion impact of a wide range of potential users in different sectors is much less a criterium. The more 'upstream' the projects, the more difficult to assess the diffusion impact. As mentioned before, tipping the scale in the direction of 'near market' research harnesses the danger of supporting 'incrementalism'. Given the large population of firms in the entire Community, this type of support will have limited impact on the absorptive capacity in the overall industrial fabric. This questions whether direct financial support to individual firms, even in pan-European networks, is the most appropriate support mechanism on Community level.

Of course it remains important that BRITE-EURAM has supported several hundreds of collaborative research and development projects in which a multiple of firms and research centres were involved. Given these figures and some of the above mentioned results that were found in the evaluations, the programme has certainly generated potential economic and social (i.e. transnational networking) impact. The challenge for the future is to find ways to improve and widen this impact. This study offers some indications on how to achieve this:

- an even better focus on technologies with a wide cross-sector impact,;
- the integration of the various elements of the innovation process in the collaborative research projects, including aspects of institutional learning;
- ensuring that firms and research centres incorporate the commercial aspects of diffusion in the early stage of proposals.

7. CONCLUSIONS

The purpose of this study is to investigate the position and status of diffusion oriented support mechanisms in RTD policy at European Community level. The empirical chapters on RTD policy (Chapter 3, 5 and 6) show a gradual shift in the support of the innovation process in EC RTD policy. The predominantly linear model, in which research is the main source of knowledge leading to innovations, has been reoriented towards a more integrated approach. In this approach innovation originates from and depends on not only research but many other functions in and around the business processes. The process is fed with a manifold of feedback linkages within and outside the firm. An awareness has grown among policy makers that the creation and exploitation of innovations is a complex process that involves many actors and skills.

This shift has not been equally far reaching in each area of RTD policy. The shift appears more clearly in Commission statements on the medium and long term overall objectives of RTD policy than in the practice of its support mechanisms. As a result, most RTD programmes are still designed according to the traditional linear model. Our overall conclusion is that *although there has been a cautious shift towards an integrated approach and diffusion oriented support, the dominant perspective in the design and implementation of EC RTD policy is still shaped by the linear model*. Consequently, despite an increased status of EC support for diffusion of technologies, its operations are defined along that same linear model. Thus dissemination of *research* results is the dominant mission of EC diffusion policy. Furthermore, diffusion still has a fairly marginal position in terms of budget and impact on the core collaborative R&D programmes.

Before we will discuss the explanatory factors for the cautious shift we will review how the results of the study have led to this conclusion.

Chapter 1 shows how the concept of diffusion has changed as a result of the shift in the perception of the innovation model. In the linear model diffusion is an 'end of the pipeline' process in which dissemination of the research results and information on new technologies is the main barrier for a more wide spread innovation. Diffusion is thus a problem of communication and distribution of information. With the development of theories on innovation, diffusion did not only receive more status, its impact was seen as an integrated part of the innovation process, instead of a separate last phase. Diffusion includes incremental innovations through new designs or applications on the basis of existing technologies. Cross-sector applications of for instance process technologies can offer an equally important contribution to innovation as the creation of new knowledge through research. The community of influential academic experts managed to influence policy makers, for a large part by their contributions as policy advisors. We have seen that in some policy documents such as the OECD TEP report and the Maastricht Memorandum, the boundaries between academic and policy interventions are blurred. Since these experts are not an interest group, this community can be expected to mediate the rational imperative of effective innovation policy.

Gradually in more and more OECD countries, this insight reached policy makers responsible for the support of innovation. Some countries like Germany already showed a tendency in this direction. Even countries that were designated as severely 'mission oriented' showed an emergence of more forms of diffusion oriented support mechanisms. The taxonomy of diffusion led support mechanisms presented in the last paragraph of the first chapter serves as a touchstone for the policy efforts of the European Community.

Our study of EC policy making distinguishes a shift of approach at two levels of analysis: in overall RTD policy, discussed in chapters 2 and 3 and at the level of the programmes and sub-programmes in chapters 5 and 6.

Chapter 3 gives the first pieces of evidence of this shift in approach at the overall level of EC RTD policy.

- There is a clear reallocation of budgets from mission oriented 'big science' projects to programmes aiming to stimulate generic technologies that have a broader, cross sector impact on manufacturing and agri-food firms. However following the discussion after the Maastricht Treaty, Delors' White Paper and the renewed commitment to subsidiarity, the fixation on 'big missions' and large scale projects has re-entered the policy debate.
- Strategic documents on RTD and industrial policy have shown an increased awareness that Europe's problem in competitiveness is not the creation of knowledge but the exploitation of that knowledge and translation into successful new products and services. Every major strategic Commission document in the late 1980s acknowledges this problem.
- New priority areas have come into the FWP's that reveal a non-linear perspective such as training, user involvement, demonstration projects.
- There is a tendency in the last few years to allow the collaborative research projects more into the application aspects of technologies. These projects are based on the combination of existing knowledge rather than on the creation of new knowledge through research. This has been clearly shown in the case of BRITE-EURAM.
- In the information technology area, at first dominated by a few 'National Champions' attempting to compete in the production of 'state-of-the-art' technologies in micro-processors, the emphasis has shifted towards the production of applications based on the core components produced by Europe's competitors. This shift was also recognised in the academic literature.

The position of diffusion oriented support was studied more closely at the level of policy programmes in the cases of SPRINT and BRITE-EURAM. The case study in chapter 5 showed that the first programme is genuinely dedicated to diffusion and has seen its budgets increased over the years. However it suffers from this dedication as well. We have seen in chapter 1 that diffusion support mechanisms involve a broad scope of activities and

domains in business innovation. Since SPRINT is quite unique in its mission, it carries the weight of having to develop initiatives on all these dimensions of diffusion: from the problem of access to risk-capital, the support of transnational technology transfer to the exchange of experience of policy makers in support mechanisms. Although each of these represents a very valid aspect of innovation support, the burden is quite heavy for a relatively small sized programme. It has lead to dispersion of initiatives and forms of experimentation.

We have shown that in BRITE-EURAM, a collaborative basic research programme, the diffusion element is less obvious. In the course of time the emphasis shifted from basic research to more applied research in generic technologies with a potential for further cross-sector use in many industries. The other side of the coin is that the programme was judged to have a too large degree of incrementalism. The strategic aspects of certain technologies, giving them a wide impact on the industrial fabric, tended to be neglected. The lesson from this case is that this type of EC support directly to firms, can only have a limited impact on diffusion, given the immense population of firms in the relevant industrial sectors.

The main difference between SPRINT and BRITE-EURAM is that in the SPRINT programme, the emphasis is on the absorptive capacity of firms, or in other words on the demand side of diffusion. Its mechanisms aim to improve the firm's learning skills in the innovation process. The BRITE-EURAM programme supports the supply side of diffusion, i.e. those firms and other bodies with R&D capacities to create new knowledge and technologies.

The case studies of the SPRINT and BRITE-EURAM programmes both confirm and clarify the conclusion:

- We have seen a development in the SPRINT programme from diffusion which was modelled by the linear approach to an integrated approach, where the absorptive capacity of the firms involved in the innovation

process is addressed in a much broader context. However we have also seen that this programme is up till now an exceptional case in the overall EC policy and relatively isolated from the core RTD programmes.

- BRITE-EURAM started as a basic research programme but soon adapted its procedures and added sub-programmes which resulted in a better contribution to diffusion. With the relaxation of the pre-competitiveness restrictions the programme moved 'downstream' and potential commercialisation of the projects became a selection criterion.

This study reveals the additional complicating factors of policy-making at the supra-national level, and the dimensions of power conflict forming the context in which RTD policy is formed. The study of RTD policy making shows that Peterson's (1991) model of policy networks needs to be extended to include the internal Commission conflicts. This leads to an intensified internal conflict between policy objectives. The Commission of the European Communities, the key actor in shaping RTD policy, does not have as long a history of regulation in industry and innovation policy as nation states have. Its regulatory style is an amalgamation of national interests and styles. The final decisions are taken in the Council so always made in compromise.

An additional complicating factor for diffusion policy is the large disparities in the Member States' innovation infrastructures and capabilities. Chapter 4 addressed this issue. The discrepancies involve the R&D inputs and outputs, the sectoral specialisation patterns reflecting technological competences and the socio-institutional context of innovation. We established in the first chapter that diffusion policy is highly dependent on the socio-institutional context of innovation. This brings up the issue of the appropriate level of policy instruments, since support mechanisms should match the specific needs of firms. We reached the conclusion that the most prominent role for Community diffusion was spreading 'best practice' in institutional aspects of innovation, such as transnational networks for firm-to-firm collaboration.

The integrated approach suggests that there is a need for different parameters to compare and analyse the diversity of national systems of innovation. The priority areas of EC technology policy were focused on either the large scale mission oriented projects or on the high-tech sectors, which has led to a geographical bias in favour of the most developed countries. Public support from an integrative perspective has a much more bottom-up approach than a 'mission-oriented' or science led has. This involves taking into account the firms' and users' needs and their socio-economic and institutional context, as Ergas (chapter 1) highlighted. A greater contribution to economic social and cohesion is often put forward as an argument in favour of diffusion policy. We have seen in the case studies that despite explicit efforts to involve participants from the less favoured regions, it is difficult to change the dominant pattern. To design and implement RTD support schemes that do not have a bias towards particular 'national systems of innovation' is almost impossible. A delicate balance between selection on the basis of technological excellence and/or best practice and an equal spread of participants has to be found. Although not all RTD programmes have been assessed on this matter, on the basis of several studies that have been discussed, we can conclude that geographical patterns of participation in the core RTD programmes confirm the disparities in innovation capabilities shown in Chapter 4.

Which factors have caused the discrepancy between a firm statement in favour of a shift of approach in Commission policy statements on the one hand and the limited shift in the implementation of support programmes on the other hand? Several explanations are possible, which we will discuss one by one. The first explanation is discussed in chapter 1: there is a time lag between changes in thinking on innovation, the awareness of policy makers of this change and the introduction of this new knowledge into the design and implementation of support mechanisms. This assumes that choices of policy-makers are completely rational and are predominantly motivated by the newest insight in theories on innovation. This would neglect the political

context in which so many different interests are involved. At the national level this time lag seems to be overcome in many countries as mentioned above. At Community level there must be additional constraining factors that have prevented diffusion led support mechanisms to takeoff as we can see in many of its Member States.

In chapter 2 we have seen that there are both constraining and facilitating factors in the **wider policy context** of EC innovation policy. Policy making at EC level is entangled in three layers of conflict, making the decision processes even more complicated compared to the national level. This chapter showed that there were forces facilitating a shift to a new approach: the principle of cohesion, increased competence in industrial policy and the case for better access to SMEs. Other political forces formed a constraint to a new approach: competition policy, and the principle of subsidiarity, which could tend to limit EC actions to large scale projects.

The principal facilitating factor that has made RTD policy reach momentum in the 1980s is the **common threat to competitiveness** of European firms vis-à-vis Japan and the United States. There is a common understanding that the EC must use its resources as effectively as possible to overcome the weaknesses underlying its inconvenient position. Growing criticism on the effectiveness and result of RTD programmes have encouraged a shift pre-competitive basic research to research projects with more commercial potential. Policy makers consult the community of innovation (policy) experts to be informed about the 'state-of-the-art' thinking on how to tackle these problems. Thus, the contributions of the expert community has a cohesive effect on the policy making process. Since they do not represent an interest group, they can be considered to mediate the common interest of effective policy making.

From the late 1980s, the increased EC competence in industrial policy vis-à-vis the Member States made it easier to implement an RTD policy that was less science and more industry oriented. The understanding that Europe is weak in commercialising its research potential which is expressed in EC documents, underpins the plea for diffusion support. In the political debates on the Framework Programme it appeared that the Member States did not agree with the Commission, when it proposed to increase support for the exploitation of research projects.

In the 1980s other factors have made diffusion a more accepted policy instrument: under influence of the cohesion discussion the call for support mechanisms that improve not only high-technology industries, but also more mature industries and SMEs in particular, became louder. Chapter 2 shows the increasing influence of less favoured countries, the main adversaries of cohesion as one of the main objectives of overall EC policy. Two opposite approaches to the Community's contribution to competitiveness were distinguished: an external one focusing on leading edge industries and an internal one focusing on the improvement of industry wide competitiveness. Alongside the fixation on high-technology in a limited number of strategic sectors, the spread of innovation capabilities in a wide range of industries, including the traditional industries in the less favoured countries, appeared on the policy agenda. This involved programmes on behalf of SMEs for which the threshold to participate in the upstream oriented research projects was much too high and for which interest in research projects with unforeseeable commercial outcomes is limited. The less favoured countries did not criticise the research orientation as such, since it was seen as a good opportunity for their - mainly public - research infrastructure to participate in the industrial projects of internationally oriented firms in the core countries. The cohesion principle was however a top-down directive, which had to be incorporated in Commission units with no affinity towards the problems of regional policy.

Chapter 2 shows how slowly the directives were incorporated in existing programmes.

There are however also forces that constrain diffusion support mechanisms to achieve greater weight at the Community level. The most decisive factor is the **inertia of the traditional linear approach** that has dominated EC innovation efforts from the very start, combined with an inclination for 'mission oriented' policy schemes.

Public administration literature suggests that for bureaucratic organisations such as the European Community, changing the policy direction is a very slow and laborious process. The dominant culture of science and research in DG XII policy units and programmes is not easily changed towards a more industrial innovation oriented culture. Claims for future budgets are made on past allocations to programmes. Once programmes have established a certain momentum, they are not easily brought to a stop, unless there is severe failure involved. Each support area has created lobby groups of beneficiaries, from research and industry, that will use their influence to prolong a policy programme. We have seen in chapter 3 that there has been a shift in emphasis between certain areas, but this was due to relative changes in a context of rising total budgets, and not because of cuts in absolute budgets.

Chapter 3 shows that for a long period EC RTD support was dominated by large scale projects in nuclear energy, illustrating the 'mission oriented' character of many European projects. The Euratom Treaty provided the basis for this 'big science' approach. In the eighties the dominant position was taken over by the priority area of information technologies. In its first booming years this policy area was dominated by the collaboration of a few 'national champions' in an attempt to catch up with the lag in the development and production of crucial electronic components. From the perspective of policy-makers, these strategic, mission oriented and large scale projects, are much more tempting to engage in. It offers an outlook on visible results, often in prestigious technological fields. Diffusion type support mechanisms have a

much more long term and intangible impact, which makes them not only less prestigious but also less easy to justify towards the political decision makers.

Public policy from an integrated perspective means the development of a whole new set of support mechanisms. The concepts around the new paradigm are still forming, and consequently the implications for public support to innovation, needs rethinking and reshaping. Support for a wide range of innovation enhancing business functions and skills, requires close coordination. The Kline and Rosenberg chain-linked model suggests that each innovation action should be embedded in a business strategy involving all business functions. Its (policy) mission will be more complicated compared to one following the linear model, where the sources and barriers for innovation are more narrowly defined. The integrated approach does not imply the abolishment of the type of support given in the linear model, such as support for R&D costs or the dissemination of research results. It involves widening the spectrum of sources of and barriers to innovation.

This study shows that it is questionable that the EC, as a bureaucratic and compartmentalised institution, is flexible enough to experiment with these new type of measures and is able to learn through 'trial and error'. Such an approach is feasible only on a limited scale, as shown in the case of the SPRINT programme. In addition, within the Commission complex **conflicts of objectives** arise. Public policy literature has concentrated on conflicting policy objectives at the national level. We have assessed the validity of Peterson's (1991) policy network concept to show that this is equally true for Community policy making, as highlighted in chapter 2. The Commission can be seen as a mirror, reflecting the compartmentalisation in and between national states. One of these conflicts is related to the policy debate on the **scope of government intervention** in industry, which is expressed in the debate on competition and industrial policy. As we could see in chapters 2, 3, 5 and 6 finding an acceptable border line of where EC intervention in industry should

cease, has been a constant issue of debate. European policy makers have to take into consideration the compromise between the non-interventionist British tradition on the one side and the 'hands-on' regulative French tradition on the other side, with the other countries somewhere in between these positions. The balance between these two positions has shifted over the years. Power conflicts between the Member States, and competition between Commission services, make it unlikely that an integrated strategy and clear vision on innovation support will emerge in the short or medium term.

More **contingent factors** have their impact as well: the isolation of diffusion programmes in Luxembourg, the political strength and approaches towards innovation of responsible Directors and Heads of Unit. Only the former has been under investigation in this study. In the case of SPRINT we could see that isolation had positive effects: the programme could experiment and develop its own philosophy and support measures. The disadvantage, as shown in chapter 5, is its little impact on the core RTD policy in other Commission units. The diffusion programmes remain isolated from other RTD areas and top ranking officials, such as the Commissioner, responsible for the strategic choices in RTD policy. The co-ordination of policies between different DGs is troublesome and the geographical divide adds to that problem.

The main problem is that the European Community, and consequently the Commission, is too divided by conflicting objectives, and its policy areas too fragmented by 'claimed territories' with fixed boundaries, to accomplish the shift towards an integrated approach to innovation. Existing policies and paradigms will determine the structure of future policies, which have slowly adapted, but not redesigned into the new paradigm. The definition of a separate 'Third activity' in the Fourth Framework Programme shows that policy makers have become aware of the significance of diffusion, but are still unable to integrate that notion into the overall RTD policy context. The best chances for the development of integrated diffusion oriented policies stems

from 'new' policy initiatives, especially where boundaries between policy competence can be overcome. Such initiatives can be found in attempts to integrate innovation policy with regional and SME policy.

This study suggests that both the emerging integrated approach to innovation and the increased emphasis on diffusion, ask for a new type of innovation support at regional, national and Community level. We have stated before that the boundaries between on the one hand the communities of innovation experts and practitioners and on the other hand the communities of policy makers are more and more blurred. The present task for both these communities is thus to formulate, design and diffuse best practice in public innovation support.

REFERENCES

- ANDERSEN, Cecilia, (1992), *Influencing the European Community, Guide lines for a successful Business Strategy*, London: Kogan Page.
- ANDERSEN, Svein S., Eliassen, Kjell, (1993), *Making policy in Europe, The Europeification of national policy-making*, London: Sage.
- ARCHIBUGI, Daniele, PIANTA, Mario, (1992), Specialisation and size of technological activities in industrial countries: The analysis of patent data; *Research Policy* 21, pp.79-93.
- ARNOLD, Erik, GUY, Ken, (1986), *Parallel convergence, National strategies in information technology*, London: Frances Pinter.
- BROWN, Lawrence A., (1981), *Innovation diffusion. A new perspective*, London: Methuen.
- BRUNET, Roger, (1989), *Les villes Europeennes, Rapport pour la DATAR (Délégation à l'Aménagement du territoire et à l'Action Régional, Groupement d'Intérêt Public RECLUS*.
- BUREAU EG-LIAISON, (1988), *Gids voor de EG-technologiefondsen*, (Guide to EC technology funding), Alphen aan de Rijn: Samson.
- (1991), *Gids voor de EG-technologiefondsen*, (Guide to EC technology funding), Alphen aan de Rijn: Samson.
- CABALLERO SANZ, Francisco; CATINAT, Michel, (1992), European Technology Policy and Cohesion: a reconciliation in practice, *Revue D'Economie Industrielle*, no. 59 1er trimestre, Paris, pp.192-203.
- CADMOS S.A., NETHERLANDS ECONOMIC INSTITUTE (NEI), BERGER, Roland, (1991), European scenarios on technological change and social and economic cohesion, MONITOR-FAST Programme, Prospective Dossier No.1, volume 16, FOP 240, Brussels: CEC.
- CAINARCA, Gian Carlo, COLOMBO, Massimo G., MARIOTTI, Sergio, (1989), An evolutionary pattern of innovation diffusion. The case of flexible automation, *Research Policy* 18, no. 2, April, pp.59-86.
- CAMAGNI, R. (ed.), 1991, *Innovation networks: Spatial perspectives*, Belhaven Press, London.
- CECCHINI, Paolo, (1988) *Alles op alles voor Europa, De uitdaging 1992, (All for Europe, The challenge 1992) Report on the 'Cost of Non-Europe'*, Amsterdam: Børsen.
- CHARBIT, C., J.-L. GAFFARD, C. LONGHI, J.-C. PERRIN, M. QURE, J.-L. RAVIX, (1991), *Coherence and diversity of systems of innovation: The study of local systems of innovation in Europe*, CNRS - LATAPSES.
- CHARLES, David and HOWELLS, Jeremy, (1992), *Technology Transfer in Europe, public and private networks*, London: Belhaven Press.
- CHESNAIS, (1993), *The French national system of innovation*, In: Nelson, Richard (ed.), *National Innovation Systems, A Comparative Analysis*, Oxford: Oxford University Press.

- CHIANG, Jong-Tsong, (1991), From 'mission-oriented' to 'diffusion-oriented' paradigm: the new trend of U.S. industrial technology policy, *Technovation*, volume 11 no. 6, pp.339-356.
- CLINTON, William J. and GORE, Albert, (1993), Technology for America's Economic Growth, A new direction to build Economic Strength, Washington D.C.: The White House, Office of the Press Secretary, February 22.
- COHENDET, Patrick; LLERENA, Patrick; SORGE, Arndt, (1992), Technological Diversity and Coherence in Europe, An analytical overview, *Revue D'Economie Industrielle*, no. 59 1er trimestre, pp.9-26.
- DAVID, Paul A., (1986), Technology Diffusion, Public Policy and Industrial Competitiveness, In: Landau, Ralph and Rosenberg, Nathan (editors), *The positive sum strategy, Harnessing Technology for Economic Growth*, Washington D.C.: National Academy Press.
- DAVIES, Stephen, (1979), The diffusion of process innovations, Cambridge University Press.
- DELORS, Jacques, (1991), The Principle of Subsidiarity: Contribution to the Debate, In: *Subsidiarity: The challenge of change*, Proceedings of the Jacques Delors Colloquium, 21-22 March 1991, Maastricht: European Institute of Public Administration.
- DIETRICH, Michael (1991), European economic integration and industrial policy, *Review of Political Economy*, 3.4. pp.418-438.
- DOSI, Giovanni, (1982), Technological Paradigms and Technological Trajectories: A suggested interpretation of the determinants and directions of technical change, *Research Policy*, vol. 11, no. 3, pp.147-162.
- DOSI, Giovanni, Christopher FREEMAN, R. NELSON, G. SILVERBERG, and L. SOETE, (1988), Technical change and Economic Theory, London: Pinter Publishers.
- DOSI, Giovanni, PAVITT, Keith and SOETE, Luc, (1990), The economics of Technical Change and International Trade, Hemel Hempstead: Harvester Wheatsheaf.
- EDQUIST, Charles; JACOBSSON Staffan, (1988), Flexible Automation, The Global Diffusion of New Technology in the Engineering Industry, Oxford: Basil Blackwell.
- ERGAS, Henry, (1986), Does Technology Policy Matter?, CEPS Papers No. 29, Brussels: Centre for European Policy Studies.
- (1992), A future for mission-oriented industrial policies? A critical review of developments in Europe, paper presented in Workshop 'Systems of Innovation', Bologna, 5-6 october 1992, organised by the University of Bologna, Dipartimento di Scienze Economiche, CEC and LATAPSES.
- ESPRIT REVIEW BOARD, (1989), The review of ESPRIT 1984-1988, The report of the ESPRIT Review Board, executive version, May.
- EUROCONFIDENTIEL, (1993), 1993 Directory of EC information sources, Rixensart: Euroconfidentiel.

- EUROPEAN NETWORK FOR SME RESEARCH, (1993) The European Observatory for SMEs, First Annual Report 1993; Report submitted to DG XXIII (Enterprise Policy, Distributive Trades, Tourism and Cooperatives) of the European Commission, Zoetermeer: EIM Small Business Consultancy.
- FAHRENKROG, Gustavo, SELMAN, Clasien, BOEKHOLT, Patricia (1993), Report for the SPRINT/EIMS Policy Workshop "New Technology Based Firms", Luxembourg, 18/19 March 1993, Commission of the European Communities, Apeldoorn: TNO- Centre for Technology and Policy Studies.
- FAHRENKROG, Gustavo, BOEKHOLT, Patricia, (1993), Report for the SPRINT/EIMS Policy Workshop "Public Measures to support the Clustering and Networks of innovative SMEs," Luxembourg, 6-7 December, Commission of the European Communities, Apeldoorn: TNO- Centre for Technology and Policy Studies.
- FORD, Glyn, LAKE, Gordon, (1991), Evolution of European science and technology policy, *Science and Public Policy*, volume 18, number 1, february 1991, pages 38-50.
- FREEMAN, Christopher (1982), The economics of Industrial Innovation, London: Pinter publishers.
- (1992), Formal Scientific and Technical Institutions in the National System of Innovation, In: Lundvall, B-Å, *National Systems of Innovation, Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London.
- FREEMAN, Christopher and PEREZ, Carlotta, (1986), The diffusion of Technical Innovations and Changes of Techno-economic Paradigm, Paper presented for the Conference on Innovation Diffusion, Ca' Dolfin, Dorsoduro 3825/E, Venice, 17-22 March.
- FREEMAN, Christopher, SHARP, Margaret and WALKER, William, (eds.) (1991), Technology and the future of Europe, Global competition and the environment in the 1990s, London: Pinter Publishers.
- GOLD, Bela, (1981), Technological diffusion in industry: research needs and shortcomings, *The Journal of Industrial Economics*, Volume XXIX, March, No. 3 pages 247 - 269.
- GRABHER, Gernot, (ed.) (1993), The embedded firm, On the socioeconomics of industrial networks, London: Routledge.
- GROENEWEGEN, Peter, FIEBELKORN, Nico, (1993), Strategic Use of R&D networks: the outcomes of EUREKA and BRITE-EURAM, Amsterdam: Free University, Faculty of Physics and Astronomy.
- GUY, Ken, (1991), Policy instruments for stimulating IT&T R&D in European Nation States; Paper prepared for DG XIII's Public Strategy Observatory, SPRU, Brighton, March.
- GUY, Ken, (1992), Making the most of collaborative R&D, presentation at BRITE-EURAM / Value information days; Conference at ICC, Birmingham, 28-29 October 1992.

- HERTOG, Pim den, LEYTEN, Jos, (1991), Europees industriebeleid en de informatietechnologie programma's (European industrial policy and the information technology programmes), *Informatie en Informatiebeleid*, spring (9) 1991, number 1, pages 47-55.
- HILPERT, Ulrich (1991), State policies and techno-industrial innovation, London: Routledge.
- HINGEL, Anders, J. (1992), Science, technology and social and economic cohesion in the Community - Along term analysis. Overall synthesis report, Brussels: CEC XII/H-3, MONITOR/FAST Programme, prospective dossier 1, Volume 1, FOP 300.
- ING Bank, (1994), Innoveren gaat niet vanzelf, De resultaten van een onderzoek onder innoverende bedrijven. (Innovation is not a matter of course, Results of a study in innovating companies), In: *Miljoenennota Midden en kleinbedrijf 1994* (Budget for SMEs), Amsterdam: Economisch Bureau ING Bank.
- IMD - WORLD ECONOMIC FORUM, (1993), The World Competitiveness Report 1993, Lausanne.
- JACOBS, Dany, BOEKHOLT, Patricia, ZEGVELD, Walter, (1990), De economische kracht van Nederland, Een toepassing van Porters benadering van de concurrentiekracht van landen, (The economic strength of the Netherlands, Applying Porter's approach of competitiveness of nations), The Hague: SMO.
- JACOBS, Dany, (1990), The policy relevance of diffusion, Report for the Policy Studies Technology and Economy, The Hague: Dutch Ministry of Economic Affairs.
- JACQUEMIN, Alexis, and WRIGHT, David, (1993) The European challenges post -1992, Shaping factors, shaping actors, Aldershot: Edward Elgar Publishing.
- KLINE, S.J., and N. ROSENBERG, (1986), An overview of innovation, In: Landau, Ralph, and Rosenberg, (eds), *The positive sum Strategy: Harnessing Technology for Economic Growth*, The National Academy Press, Washington D.C..
- LLERENA, Patrick, (1992), Introduction of special issue of *Revue D'Economie Industrielle*, Technological Diversity and Coherence in Europe, no. 59, first trimester, Paris.
- LUNDVALL, Bengt-Åke (ed), (1992), National Systems of Innovation, Towards a Theory of Innovation and Interactive Learning, London: Pinter Publishers.
- MASSEY, Doreen, QUINTAS, Paul, and WIELD, David, (1992), High-Tech Fantasies, Science Parks in society, science and space, London: Routledge.
- METCALFE, Stan, (1990), On diffusion, Investment and the Process of Technological Change, paper for conference 'Technology and Investment', of the Royal Swedish Academy of Engineering Sciences (IVA) and the Swedish Ministry of Industry, in co-operation with the OECD, Stockholm 21-24 January.

- MINISTRY OF ECONOMIC AFFAIRS, (1993), *Concurreren met kennis* (Competing with knowledge), White paper on technology policy, The Hague: SDU.
- MOLINA, Alfonso, (1990), 1992 and European integration, Opportunities and difficulties in high-technology collaboration, *Futures*, June, pp.496-514.
- MOWERY, David, ROSENBERG, Nathan, (1979), The influence of market demand upon innovation: a critical review of some recent empirical studies, *Research Policy*, number 8, pp.102-153.
- MYTELKA, Lynn Krieger, DELAPIERRE, Michel, (1987), The alliance strategies of European firms in the information technology industry and the role of ESPRIT, *Journal for Common Market Studies*, Volume xxvi, No. 2, December, pp.231-253.
- NABSETH, L and RAY, G.F. (editors), (1974), *The diffusion of New Industrial Processes: An international study*, London: Cambridge University Press.
- NELSON, R.R. and WINTER, S.G., (1977), In search of Useful Theory of Innovation, *Research Policy*, 6, pp.36-76.
- (1982), *An Evolutionary Theory of Economic Change*, Cambridge: Harvard University Press.
- NELSON, Richard, (1988), Institutions supporting technical change in the US, In: Dosi, G. et al., *Technical Change and Economic Theory*, London: Pinter Publishers.
- NELSON, Richard (ed), (1993), *National Innovation Systems, A Comparative Analysis*, Oxford: Oxford University Press.
- NICOLAIDES, Phedon (ed.), (1993), *Industrial policy in the European Community: a necessary response to economic integration?*, European Institute of Public Administration, Maastricht, Dordrecht: Martinus Nijhoff.
- NUGENT, Neill, (1991), *The government and politics of the European Community*, second edition, Basingstoke: Macmillan.
- OECD, *The Technology/Economy Programme (TEP)*, (1991), *Technology in a changing world*, Paris.
- (1992a), *Technology and the Economy, The key relationships*, Paris.
- (1992b), *Main science and technology indicators*, Paris.
- OHMAE, Kenichi, (1985), *Triad Power: the coming shape of global competition*, New York: The Free Press, .
- PATEL, Pari, PAVITT, Keith, (1991), Europe's technological performance; In: Freeman et al., *Technology and the future of Europe, Global Competition and the environment in the 1990s*, London: Pinter Publishers.
- PAVITT, Keith, (1984), Sectoral Patterns of technical change: Towards a taxonomy and a theory, *Research Policy* 13, 343-373.
- PEIRCE, William S., (1991), Innovation and Diffusion in the "Single Europe", *Technological Forecasting and Social Change*, no. 39, pp.35-44.
- PELKMANS, Jacques, (1988), Naar een EG-beleid voor geavanceerde markten, (To an EC policy for advanced markets), in: Schenk, H.; *Industrie- en technologiebeleid*, Groningen: Wolters.

- PETERSON, John, (1991), Technology Policy in Europe: Explaining the Framework Programme and Eureka in Theory and Practice, *Journal of Common Market Studies*, Volume XXIX, No. 3 March, pages 269 -290.
- PORTER, Michael, (1990), The Competitive Advantage of Nations, New York: Free Press.
- RAY, George F., (1989), Full circle: The diffusion of technology, *Research Policy* 18, pages 1-18.
- ROGERS, Everett M, (1983), Diffusion of innovations, New York: Free Press.
- ROOBEEK, Annemieke, (1988), Een race zonder finish, De rol van de overheid in de technologiewedloop, (A race without finish, The role of the government in the technology race), Amsterdam: VU Uitgeverij.
- (1990), European technology policy from a future perspective, *Futures*, November 1990, pages 904-912.
- (1991), The political dimension of European technology policy, A critical evaluation of the benefits of European technology programmes with regard to smaller EC countries; Background paper for the 2nd International Workshop "Ways out of the restructuring race - Can small political and economic entities sustain a welfare orientation in an internationalising world economy", University of Amsterdam, Department of International Affairs, December 11-14, 1991. Amsterdam: University of Amsterdam, Faculty of Economics and Econometrics.
- ROSCAM ABBING, Michiel, SCHAKENRAAD, Jos, (1990), Joint R&D activities of firms in European cost-sharing programmes, Maastricht: MERIT Research Report 90-014.
- (1991) Intended and unintended effects of participation in ESPRIT and EUREKA for small countries industrial policies, Maastricht: MERIT Research Report 91-001.
- ROSENBERG, Nathan, (1976), Perspectives on technology, Cambridge: Cambridge University Press.
- (1982), Inside the Black Box: Technology and economics, Cambridge: Cambridge University Press.
- ROTHWELL, Roy and ZEGVELD, Walter, (1985), Reindustrialization and Technology, London: Longman, Harlow.
- ROTHWELL, Roy and DODGSON, Mark, (1989), Regional technology policies: the development of regional technology transfer infrastructures; SPRU Paper prepared for the "Third International Workshop on Innovation, Technology Change and Spatial Impacts, september 1989, Cambridge.
- (1990), National and regional technology policies in Europe: trends and convergence", *European Research*, November, pages 7 - 13.
- SANDHOLTZ, Wayne, (1992), ESPRIT and the politics of international collective action, *Journal of Common Market Studies*, Volume XXX, No. 1 March.

- SEGAL QUINCE WICKSTEED LIMITED, VDI/VDE-IT, TNO CENTRE FOR TECHNOLOGY AND POLICY STUDIES, CENTRALE MANAGEMENT, L. TSIPOURI, (1993), Evaluation of SPRINT action on transnational networks of interfirm technological cooperation, A report to the Commission of the European Communities, Cambridge: SQW, September.
- SERVAN-SCHREIBER J.J., (1970) De Amerikaanse uitdaging (The American challenge, original title: Le défi américain, 1967), Utrecht: Bruna.
- SHARP, Margaret, (1989), Corporate strategies and collaboration: the case of ESPRIT and European electronics, In: Dodgson, Mark; *Technology strategy and the firm: management and public policy*, London: Longman, Harlow.
- SKOIE, Hans, (1993), EC Research and technology policies, Some characteristics of its development and future perspectives, Paper presented at the EASST workshop on 'EC science and technology policies', Rome, September 23-24 1993.
- SOETE, Luc L.G., (1984), Long cycles and the international diffusion of technology; In Freeman, Christopher (editor), *Design, Innovation and long cycles in economic development*, Proceedings of an International Seminar, April 1983, Royal College of Art, Department of Design Research, London.
- SOETE, Luc, and A. ARUNDEL, (1993), An integrated approach to European Innovation and Technology Diffusion Policy, A Maastricht Memorandum, Brussels-Luxembourg: CEC, DG XIII, EUR 15090 EN, May.
- STARBATTY, Joachim, VETTERLEIN, Uwe, (1989), Spitzentechnologie oder innere Kohäsion, Ein technologiepolitischer Zielkonflikt in der Europäischen Gemeinschaft, (High-technology or internal cohesion, A conflict of technology policy objectives in the European Community), *Europa-Archiv*, number 5, pp.145-154.
- (1990), Die Technologiepolitik der Europäischen Gemeinschaft, Entstehung, Praxis und ordnungspolitische Konformität, (EC technology policy, the start, practice and regulative conformity), Baden-Baden: Nomos Verlagsgesellschaft.
- STEIN, Josi, (1993), The UK and International Collaboration in R&D: The role of the European Community, presentation at the EASST workshop on 'EC science and technology policies', Rome, September 23-24 1993.
- TANG, Matthias, (1992), Die Forschungs- und Technologiepolitik der Europäischen Gemeinschaft, Entwicklungslinien und Widersprüche, (The EC research and technology policy, trends and conflicts), *Wechselwirkung*, nr. 55, June.
- TECH EUROPE, Monthly bulletin on developments in European Community RTD policy, Volumes 1991 to July 1994, Brussels: European Information Service (EIS).

- TEECE, David, (1986), Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, *Research Policy* 15, pp. 285-305.
- TII, (1993), Directory of members, 1993/1994, Luxembourg: TII -European Association for the Transfer of Technologies, Innovation and Industrial Information.
- TROUSSON, P., (1992), The Value programme; presentation at the BRITE-EURAM / Value information days; Conference at ICC, Birmingham, 28-29 October 1992.
- UTTERBACK, James M., (1974), Innovation in Industry and the Diffusion of Technology, *Science*, volume 183, 15 February.
- WALSH, Vivien, (1984), Invention and innovation in the chemical industry: Demand-pull or discovery push? *Research Policy* 13, pp.211-234
- WILLIAMS, Roger, (1989), The EC's Technology Policy as an engine for integration, *Government and Opposition*, volume 24, number 2, spring.
- ZYSMAN, John, TYSON, Laura, DOSI, Giovanni, COHEN, Stephen, (1990), Trade, technology and national competition, In: Deiaco, E., Hörnell and Vickery, *Technology and Investment, Crucial Issues for the 1990s*, London: Pinter Publishers.

EUROPEAN COMMUNITY AND EUROPEAN UNION SOURCES OF INFORMATION

COMMISSION OF THE EUROPEAN COMMUNITIES;

(1980), Het onderzoeksbeleid van de Europese Gemeenschap (The EC research policy), European Documentation, DG IX/E/5 - Coordination and preparation of publications, script by Maass, Kurt-Jürgen, European Documentation, Journal 5/1980;

(1981) Het wetenschappelijk en technisch onderzoek en de Europese Gemeenschap, Voorstellen voor de jaren 1980 (The scientific and technological research and the European Community, Proposals for the 1980s), COM (81) 574 def. Brussels, 12 October.

(1982) Transfer and exploitation of scientific and technical information, Proceedings of the symposium held by the Commission of the European Communities, Directorate General Information market and innovation in Luxembourg, 10 to 12 June 1981. Coordinated by J. Michel Gibb, EUR 7716, Luxembourg: Office for Official Publications of the European Communities.

(1983a) Proposal for a European strategy in the field of science and technology, Framework Programme 1984-1987, COM (82) 865 def. Brussels, 19 January.

(1983b) Proposal for a Council Decision concerning the Framework Programme for scientific and technological activities of the Community 1984-1987, COM (83) 260 def, Brussels, 24 May.

(1983c), Proposal for a Council Decision adopting a multi-annual programme of the European Economic Community for research and development in the field of basic technological research, Proposal for a Council Decision adopting a multi-annual programme of the European Economic Community for research and development in the field of applications of new technologies, (presented by the Commission), COM(83) 350 def, 18.7.1983, Brussels.

(1984), Call for proposals for support of European conferences on technology and innovation, (84/C210/02), OJ C210, 10.8.1984.

(1985a), Community research and technology policy: developments up to 1984, EUR 10000, 1985, Luxembourg: Office for Official Publications of the European Communities.

(1985b), The European Community's research policy (second edition), European Documentation, Journal 2/1985, DG IX/D/5 - Co-ordination and preparation of publications.

- (1985c) Advance notice for participation in BRITE (Basic Research in Industrial Technologies for Europe) (85/C 27/02), OJ No C27, 29.1.1985, p.2.
- (1985d) Call for proposals for support of transnational cooperation between advisory organisations on technology and innovation management for SMEs, (85/C 125/04), OJ C125, 22.5. 1985.
- (1985e) Memorandum "Towards a European Technological Community, COM (85) 350 def., Documents, Luxembourg: Office for Official Publications of the European Communities, 25 May.
- (1985f) Implementation of the Commission Memorandum "Towards a European Technological Community, COM (85) 530 def., Documents, Luxembourg: Office for Official Publications of the European Communities, 30 September.
- (1985g) Completing the internal Market, White paper from the Commission to the European Council, COM document.
- (1985h) First annual progress report of the "Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer", COM (85) 274 final, Brussels, 4 June.
- (1986a) Call for proposals for support of transnational cooperation between advisory organisations on technology and innovation management for SMEs, (86/C 40/02), OJ C40, 21.2.86.
- (1986b) Staatssteun voor onderzoek en ontwikkeling: een communautair kader (State Aid for research and development: a Community framework), (86/C 83/02), OJ C 83, 11.4.86.
- (1986c) Proposal for a Council regulation concerning the Framework Programme of Community activities in the field of research and technological development (1987 to 1991), COM (86) 430 final, Brussels, 5 August.
- (1986d) Communication from the Commission to the Council, on the extension and the revision of the "Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer", ("SPRINT"programme), Proposal for a Council Decision, modifying Council Decision 83/624/EEC concerning a plan for the transnational development of the supporting infrastructure for innovation and technology transfer, Second annual progress report of a Council Decision (83/624/EEC), COM (86) 483 final, Brussels, 14 october.

(1986e) Proposal for a Council decision to modify Council Decision of 83/624/EEC concerning a plan for the transnational development of the supporting infrastructure for innovation and technology transfer. (Submitted by the Commission to the Council on October 16th 1986), (86/C278/03), Preparatory Acts, OJ C 278, 4.11.86.

(1986f) The SPRINT programme, The Community's contribution to innovation and technology transfer, *European File* 18/86, Brussels: Directorate-General for Information, Communication and Culture, November.

(1986g) Proposal for a Council decision to modify Council Decision of 83/624/EEC concerning a plan for the transnational development of the supporting infrastructure for innovation and technology transfer. (COM (86) 483 def. (Submitted by the Commission to the Council on October 16th 1986), (86/C 335/13), This proposal annuls and replaces proposal (COM (86) 483 def.). OJ C335, 30.12.86

(1987a) Communication from the commission to the Council, on the review of the multiannual research and development programme in the fields of basic technological research and the applications of new technologies (BRITE) (1985 - 1988), COM (86) 271 final, 21.5.1986, Brussels.

(1987b) Proposal for a Council decision to revise the multi-annual research and development programme in the field of basic technological research and application of new technologies (BRITE) (1985-1988), COM(87) 307 final, 22.7.1987, Brussels.

(1987c) Commission communication regarding calls for proposals and for expression of interest concerning the implementation of the SPRINT programme (Strategic Programme for Innovation and Technology Transfer), (87/C 196/02), OJ No C 196, 25.7.87

(1987d) Proposal for a Council decision to amend Decision 85/196/EEC concerning a multi-annual research and development programme of the European Economic Community in the fields of basic technological research and application of new technologies (BRITE) (1985-1988), presented by the Commission, (document replaces COM(87) 307 def), COM (87) 307 def./2, 28.9.1987, Brussels.

(1987e) Amendment to proposal for a Council Decision, amending Decision 85/196/EEC concerning a multi-annual research and development programme of the European Economic Community in the fields of basic technological research and application of new technologies (BRITE) (1985-1988), (presented by the Commission according to Article 149, paragraph 3 of the EEC Treaty), COM (87) 671 def. 3.12.1987, Brussels.

(1988a) Het beleid voor onderzoek en technologische ontwikkeling, (The policy for research and technological development), DG IX/E/5 - Coordination and preparation of publications, by Michel André, European Documentation, Journal 2/1988, Luxembourg: Office for Official Publications of the European Communities

(1988b) Advance notice for participation in the Brite/Euram programme (88/C 196/04), OJ No C 196, 26.7.1988.

(1988c) Evaluation of the first BRITE programme (1985-1988), authors: Farge, Y., Baechler, W.G., Freese, J., Guasch Molins, M., Higgins, T., Roach, R., Scherillo, A., Theocaris, P.S., Research Evaluation - Report No. 25 EUR 11782 EN, July.

(1988d) Proposal for a Council Decision adopting a specific research and technological development programme of the European Economic Community in the fields of industrial manufacturing technologies and advanced materials applications (BRITE/EURAM) (1989 to 1992), COM (88) 385 final SYN 142, Submitted by the Commission on 29 July 1988), OJ C 228, 3.9.1988, p.3.

(1988e) Proposal for a Council Decision adopting a specific research and technological development programme of the European Economic Community in the fields of industrial manufacturing technologies and advanced materials applications (BRITE/EURAM) (1989 to 1992), (This document cancels and replaces document COM(88) 385 final - syn 142), COM(88) 385 final - SYN 142/2 23.08.1988, Brussels.

(1988d) Amendment to proposal for a Council Decision adopting a specific research and technological development programme of the European Economic Community in the fields of industrial manufacturing technologies and advanced materials applications (BRITE/EURAM) (1989 to 1992), COM (88) 830 def. - SYN 142, 9.12.1988, Brussels.

(1989a) Call for proposals for participation in BRITE/EURAM (Manufacturing Technologies and Advanced Materials 1989 to 1992). OJ No C 14, 18.1.1989.

(1989b) Amended proposal for a Council Decision concerning the implementation at Community level of the main phase of the strategic programme for innovation and technology transfer, SPRINT (1989 to 1993), COM (89) 105 final, (89/C 68/12), OJ C 68, 18.3.89.

(1989c) Call for proposals for the definition phase of specific projects for intra-Community innovation transfer as part of the implementation of the SPRINT programme (89/C 185/12), OJ No C185, 22.7.89.

- (1990a) Proposal for a Council Decision adopting a specific research and technological development programme in the field of industrial and materials technologies (1990 to 1994), presented by the Commission, COM (90) 156 final - SYN 261, 28.5.1990, Brussels.
- (1990b), Industrial policy in an open and competitive environment, Guidelines for a Community approach, COM(90) 556 final, 16 November 1990, Brussels.
- (1990c) Amended proposal for a Council Decision adopting a specific research and technological development programme in the field of industrial and materials technologies (1990 to 1994), COM(90) 673 final - syn 261, OJ No C 14, 22.1.1991, p.12
- (1991a), The European Electronics and information technology industry: State of play, issues at stake and proposals for action, SEC(91) 565 final, Brussels, 3 April.
- (1991b) Proposal for a Council Decision, adopting the Workprogramme for the implementation of the specific programme of research and technological development in the field of Industrial and materials technologies (1991-1994), (presented by the Commission), COM (91) 361 final, 21.10.1991, Brussels.
- (1991c) Call for proposals for the specific programme of research and technology development in the field of industrial and materials technologies (Areas 1 & 2), BRITE/EURAM II, OJ No C333, 24.12.1991, p.13.
- (1992a) Research after Maastricht: An Assessment. A Strategy, Communication from the Commission to the Council and the European Parliament, SEC(92) 682 final, Bulletin of the European Communities, Supplement 2/92, Luxembourg: Office for Official Publications of the European Communities.
- (1992b) Van Europese Akte naar de Post-Maastrichtse periode, De middelen voor onze ambities, (From the Single European Act to the post-Maastricht period, The resources for our ambitions, COM (92) 2000 def, Brussels: 11 February.
- (1992c) EC Research Funding, A guide for applicants, DG XIII, Brussels, September 1992.
- (1992d) Research after Maastricht: An Assessment. A Strategy, Draft Communication from the Commission to the Council and the European Parliament.
- (1993a), Growth, Competitiveness, Employment, The challenges and ways forward into the 21st Century, White Paper, Bulletin of the European Communities, Supplement 6/93, Luxembourg.

(1993b) Proposal for Council Decisions concerning the fourth Framework Programme of Community activities in the field of research and technological development (1994-1998), Draft version of working document.

COMMISSION OF THE EUROPEAN COMMUNITY - DG III, (Industry)

(1993) Panorama of EC Industry, CEC, Luxembourg.

COMMISSION OF THE EUROPEAN COMMUNITIES,
DIRECTORATE GENERAL XII,

(1986) Information Package, for the second call for proposals for the European Community Programme: BRITE, Basic research in industrial technologies for Europe, Directorate : Technological research.

(1989) Community research & development programme on manufacturing technologies and advanced materials (1989-1992), Information package for the first call for proposals, Directorate Technological Research, BRITE/EURAM

(1990a) Stimulering van onderzoek en technologie door de EG, Vademecum voor geïnteresseerden, (EC Research and technology funds, a guide.) L. Krickau-Richter, O. von Schwerin, April, Brussels.

(1990b) Feasibility Awards for Small and Medium sized Enterprises, 1990, Synopsis of supported projects

(1990c) Management report on the BRITE-EURAM programme, XII/435/90 -EN, July, (not published).

(1991) Industrial & Materials technologies (BRITE-EURAM II) 1991-1994, Information package, Edition 1991.

(1992a) Industrial & Materials technologies (BRITE-EURAM II) 1991-1994, Information package, Reprinted Edition.

(1992b) Brite & Euram, Evaluation study of finished projects: synthesis report, Projects completed by December 1991, Industrial and Materials Technologies (Brite-EuRam II) in collaboration with VALUE, Luxembourg: Office for Official Publications of the European Communities.

(1992c) Brite & Euram, Finished Projects Volume 1, Projects completed by December 1990, Industrial and Materials Technologies (Brite-EuRam II), Luxembourg: Office for Official Publications of the European Communities.

(1992d) Brite & Euram, Finished Projects Volume 2, Projects completed by December 1991, Industrial and Materials Technologies (Brite-EuRam II), Luxembourg: Office for Official Publications of the European Communities.

(1992e) BRITE-EURAM, 1991: Call for proposals, Final list of selected projects, classified by research area, October.

(undated) BRITE-EURAM, The R&D programme for Advanced Production technologies for Industry, Information brochure.

(undated) VALUE, Community programme for the diffusion and utilization of scientific and technological research results, Information brochure, Luxembourg: Office for Official Publications of the European Communities.

COMMISSION OF THE EUROPEAN COMMUNITIES, DIRECTORATE GENERAL XIII

(1986), Second Annual Progress Report, Plan for the Transnational Development of the Supporting Infrastructure for Innovation and Technology Transfer, Council Decision (83/624/EEC) of November 1983, *Newsletter new technologies and innovation policy*, No. 55 special, Supplement to Euroabstracts, EUR 9998, Luxembourg.

(1988) Evaluation of the European Advanced Materials Research Programme - EURAM - (1986-1989), authors: Costa, P., Ascarelli, P., Bloyaert, F., Haines R.C., Meyer-Kramer, F., Widmark, H., Research Evaluation - Report No. 33 EUR 11950 EN, November, Luxembourg: Office for Official Publications of the European Communities.

(1989a) Introduction to the SPRINT main programme 1989-93, presentation by R. Miège and D. Janssens, SPRINT directorate, July.

(1989b) Transnational Technology Transfer Networks, Improving network efficiency, SPRINT presentation at contractors conference 10-12 July, Luxembourg.

(1989c) Specific Projects, Information and application package, SPRINT.

(1990a) Call for tenders European Innovation Monitoring System, Information and Application Package.

(1990b) BRITE EURAM programme, Synopsis of current projects 1989 - 1990, including projects running under BRITE and EURAM, Scientific and Technical Communication Unit, Publication No. EUR 12600, Luxembourg: Office for Official Publications of the European Communities.

- (1990c) The European network for technological interfirm co-operation, Luxembourg: SPRINT programme, April.
- (1990d) EC Research Funding, A guide for applicants, prepared by Krickau-Richter, L. and Schwerin, O. von, Luxembourg: Office for Official Publications of the European Communities.
- (1991a) BRITE EURAM programme, Synopsis of current projects 1990 - 1991, including projects running under BRITE and EURAM, Second edition, Scientific and Technical Communication Unit, Luxembourg: Office for Official Publications of the European Communities.
- (1991b) Sprintlink 1991, Proceedings of SPRINT contractors conference, Luxembourg 29-30 January 1991, Report EUR 13773, Edited by J.T. McMullan, Final Report, Luxembourg: Office for Official Publications of the European Communities.
- (1991c) SPRINT Committee on innovation and technology transfer and its thematic working groups, February.
- (1991d) SPRINT, The European Community programme for innovation and technology transfer 1989-1993, Mid term-status report, 15 July.
- (1991e) SPRINT, The European Community programme for innovation and technology transfer 1989-1993, Profile, 25 July.
- (1992) EC Research Funding, A guide for applicants, 3rd fully revised edition, prepared by Krickau-Richter, L. and Schwerin, O. von, Luxembourg: Office for Official Publications of the European Communities.
- (1992b) SPRINT specific projects for intracommunity innovation transfer, Project synopsis projects in implementation, 1989 and 1990 calls for proposals, Luxembourg: SPRINT, January.
- (1992c) Feasibility assessment and planning of SPRINT specific projects, A planning guide for the definition phase of SPRINT specific projects, 28 January.
- (1993a) Strategic Programme for innovation and technology transfer (SPRINT), Mid-term review, R. Quince, EUR 14643, Luxembourg: Office for Official Publications of the European Communities.

(1993b) Industrial & Materials Technologies BRITE-EURAM II, Synopsis of current projects 1993, including projects running under BRITE and BRITE/EURAM, 93 edition, Publication no. EUR 14534, Scientific and Technical Communication Unit, Luxembourg: Office for Official Publications of the European Communities.

(1993c) Evaluation of the BRITE/EURAM Programme (1989-1992) - (areas 1 to 4), authors: Schiele, O., Airaghi, A., Bloyaert, F., Jarillo, J.C., Kärnä, A., Lavalou, M., Paul, L., Weaver, L., Research evaluation - Report No. 53, EUR 15070 EN, February, Luxembourg: Office for Official Publications of the European Communities.

(1993d), Specific projects for intracommunity innovation transfer, Project synopsis projects in implementation, 1989 and 1990 calls for proposals, Luxembourg: SPRINT, January.

(1994) SPRINT presentation, TII conference: Technology transfer practice in Europe, Experiences of the last ten years and developments to the year 2000, Hannover, April 28-29 1994, SPRINT contractors meeting.

(undated a) SPRINT, The European Community programme for innovation and technology transfer 1989-1993, Information package with press releases and articles on SPRINT, including article by Ian Traill, National expert SPRINT programme, The SPRINT technology transfer networks, TII focus 1991.

(undated b) Specific Projects Action Line, SPRINT information brochure.

EUROPEAN COMMISSION

(1994), BRITE-EURAM, A measurable impact, A synthesis of the 1993 Evaluation studies of the Industrial and Materials Technologies Programme, Luxembourg: Office for Official Publications of the European Communities.

CIT (COMMITTEE ON INNOVATION AND TECHNOLOGY TRANSFER)

(1990), SPRINT Technology Networks: initiatives to encourage long term self-sufficiency, Working document, CIT (90)39, September.

(1991), The European Community SPRINT programme 1989-1993, Profile of an Innovation and technology transfer programme, CIT (91) 24, Luxembourg.

COUNCIL OF THE EUROPEAN COMMUNITIES

(1983) Council decision of 25 november 1983 concerning a programme for the transnational development of the supporting infrastructure for innovation and technology transfer, (83/624/EEC), OJ No. L353 15/12/ 1983

(1987) Council decision of 9 June 1987 on the implementation of the Strategic Programme for Innovation and Technology Transfer (SPRINT), (87/307/EEC), OJ No. L 153 13.6.1987.

(1988) Council Decision of 29 February 1988, amending Decision 85/196/EEC concerning a multi-annual research and development programme of the European Economic Community in the fields of basic technological research and application of new technologies (BRITE) (1985 to 1988), (88/108/EEC), OJ No L 59, 4.3.1988.

(1989) Council Decision of 14 March 1989 on a specific research and technological development programme in the field of industrial manufacturing technologies and advanced materials applications (BRITE/EURAM) (1989 to 1992), OJ No L 98, 11.4.1989.

(1989b) Council Decision of 17 April on the implementation at Community level of the main phase of the strategic programme for innovation and technology transfer (1989 to 1993) (SPRINT programme), (89/286/EEC), OJ No L 112, 25.4.89.

(1990) Council decision of 23 April 1990 concerning the framework programme of Community activities in the field of research and technological development (1990 to 1994) (90/221/Euratom, EEC), OJ No L117/28.

(1991) Council Decision of 9 September 1991, adopting a specific programme of research and technological development in the field of industrial and materials technologies (1990 to 1994), (91/506/EEC), OJ No L 269, 25.9.1991.

(1991b) Council Decision of 19 December adopting the work programme for the implementation of the specific programme of research and technological development in the field of industrial and materials technologies (1991 to 1994), OJ No L 375, 31.12.1991, p. 18.

(1992) European Council Edinburgh 11-12 December 1992, Conclusions of the presidency, Luxembourg: Office for Official Publications of the European Communities.

EUROSTAT

**(1991), Government financing of research and development 1980 - 1990,
Luxembourg: Statistical Office of the European Communities.**

APPENDIX I: PERSONS INTERVIEWED

First Head of Unit for SPRINT (1983-1986),
CEC DG XIII

Present Head of Unit, CEC DG XIII/D SPRINT
programme

Formerly national expert for DG XIII, SPRINT

CEC/DG XII/C BRITE-EURAM

CEC/DG XII/C BRITE-EURAM

CEC/DG XII/C BRITE-EURAM

3 Formerly national expert for DG XIII/1

Member of European Parliament, Member of
Committee on Energy, Research and Technology

Ministry of Economic Affairs Netherlands and
member of SPRINT committee on innovation
and technology transfer

Ministry of Economic Affairs Netherlands and
member of SPRINT committee on innovation
and technology transfer

Aston University

Content has been removed for copyright reasons

APPENDIX II: SOURCES OF INFORMATION ON EUROPEAN COMMUNITY RESEARCH AND TECHNOLOGICAL DEVELOPMENT POLICY

The most important source reference is *The Official Journal* (OJ) which is published virtually daily and contains the authoritative record of decisions, announcements and activities. It is divided into two series: the Legislation series, which contains a large part of the regulations and the Communication series which contains communications and information. In addition, there are the Supplement series which publishes notices of public works and invitations to tender from the European Development Fund. The latter series is hardly relevant for RTD policy. The L series contains Council decisions on RTD and related policies including decisions on the allocation of budgets to the RTD areas and programmes. Proposals from the Commission can be found in the C series, in the form of Communications. Examples are proposals for medium-term decisions on RTD policy, structured by the so called Framework Programmes. Both series have an annual Index which can be used to select the key documents. Other methods to select the important documents are identification through references in the principle Commission documents and in academic literature. Before a Commission communication reaches the Official Journal and thus receives official status, numerous drafts are written and circulated between Commission services and officials (see chapter 2). Reports that aim to propagate an opinion of a certain Commission services are called *Working documents*. See for an overview of EC information sources the Euroconfidentiel, *Directory of EC information sources*, published annually and Nugent (1991).

Other sources on the EC are press articles, academic literature, and information journals published by the Commission. A useful systematic source on developments in EC innovation policy is *tech europe*, a monthly publication from Europe Information Service (EIS) based in Brussels. The relevant Commission journals are *I&T magazine* (previously called the *DG XIII magazine*) published every three months jointly by DG III and DG XIII and the newsletter *Innovation and Technology Transfer*, also published by DG XIII.